TS-9720EN Series Progressive Scan Shutter Cameras

Operation Manual

10157
Rev. A

iAi PULNiX®
Imaging Products

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EN55024: 1998 + A1: 2001 + A2: 2003

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WARNING

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

TS-9720EN Series Operation Manual
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TS-9720EN Series Progressive Scan Shutter Cameras

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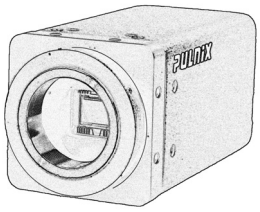


1 Introduction

1.1 Scope of this Manual

This manual covers the operation of the TS-9720EN/TSC-9720EN traffic control camera.* For information on how to operate the associated software, please see the software manual.

1.2 Related Documents

- Lane Controller to Ethernet Network Camera Interface Document, doc. number 69-1198
- Vehicle Imaging System 300 (VISCAM300) Camera Hardware Interface Definitions, doc. number 4087.72.002
- Vehicle Imaging System 300 (VIS300) Installation Manual, doc number 4087.72.004
- Vehicle Imaging System 300 (VIS300) EN Setup User's Guide, doc number 4087.72.005

1.3 Key Functions of the TS-9720EN Camera

- Sensitive high-speed 2/3" progressive scan CCD camera
- 10/100 Mbit BaseT Ethernet interface
- External event trigger function for full-frame single/multiple image capture
- Triggering capability using Ethernet, TTL or serial (RS-485)
- Built-in PowerPC processor running Linux O/S
- 64MB SDRAM for image buffering

*. Unless specifically mentioned, all information in this manual is relevant to both the TS-9720EN camera (monochrome) and the TSC-9720EN camera (color).

- Static/DHCP support for TCP/IP configuration
- Image transfer over Ethernet using FTP over TCP/IP
- Frame date/time stamp facility with user-definable text strings
- High quality JPEG encoding
- Automatic dynamic range control and maximum contrast images using the optional Smart Light Sensor

1.4 Product Description

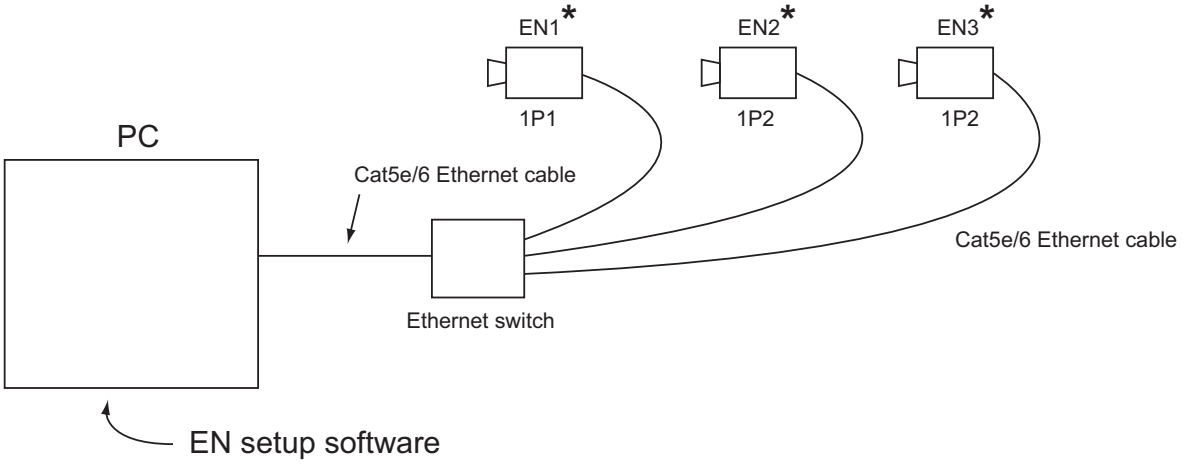
The TS-9720EN camera is an all-in-one progressive scan and Ethernet CCD camera, with a built in image capture/storage function, and image-processing software using a built-in PowerPC processor. The TS-9720EN performs JPEG compression and automatic FTP transmission of captured images to a file server.

Typical applications for the TS-9720EN include Automatic Number Plate Reader (ANPR/ LPR), vehicle fingerprints (vehicle matching technology), optical character recognition (OCR), and region-of-interest extraction (ROI), as used in the market for ITS (Intelligent Transportation Systems). The TS-9720EN supports external event triggering, dynamic light sensor and tampering alarm input, and provides the best quality and sensitivity images for ITS applications. Applications include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

2 Getting Started

2.1 Required Equipment

FIGURE 1. Typical Equipment Setup



*Each camera requires a PD-12 12-V power supply.
For details, please see “Power Supplies and Cable Setup.”

- PD-12 power supply
- Cat5e/6 Ethernet cable
- 10/100/1 G Ethernet switch
- Debug-232 serial/power cable (JAI PULNiX part number 31013219)

2.2 Network Settings

2.2.1 Default Network Settings for the TS-9720EN Camera

The factory default network setting for the TS-9720EN is the following:

IP address : 10.0.0.65

Subnet mask : 255.255.255.0

Default gateway : 255.255.255.255 (disabled)

You must set up your computer network properly in order to allow it to communicate with the TS-9720EN camera. It is very important to that your PC NOT be assigned the same IP address as the camera. If you need to change the IP address, follow the instructions in Section 2.2.2 on page 4.

2.2.2 Changing the IP Address of the TS-9720EN Camera

If you need to change the IP address of your TS-9720EN camera, you can do so using either the EN setup software or the debug RS-232 serial/power cable. Choose the method that is most appropriate for your application, and follow the steps listed.

2.2.2 (a) Changing the IP Address of the TS-9720EN Camera Using the EN Setup Software

You can use the EN setup software to change the IP address of the TS-9720EN camera. To so do, follow the steps below.

1. First, set up your PC's network setting properly so that your PC has the 10.0.0.XX subnet. However, XX must not be 65, because the host PC's IP address cannot be the same as that of the camera. The subnet address must be 255.255.255.0.
2. Next, open the EN setup software. If you are starting this software for the first time, you will be asked to type your password. Your case-sensitive user name and password are as follows:

   User name: Administrator

   Password: Password
3. Click the "Properties" button. You will see the EN cameras that are in the network.
4. Click the icon of the camera you want to change. Once it is selected, find the "IP address" register and change the IP address of the camera.
5. Right-click on the camera icon and select "Reboot." This option will reboot the camera.
6. The camera will now start up with a new IP address.

2.2.2 (b) Changing the IP Address of the TS-9720EN Camera Using the Debug RS-232 Serial/ Power Cable

You can use the debug RS-232 serial/power cable to access the BIOS menu and change the IP address of the TS-9720EN camera. To do so, follow the steps below.

1. First set up your hyperterminal as 9600-8-N-1. Start up the TS-9720EN. You should now see the BIOS start-up code.
2. Type "/" to stop the normal camera boot-up and to start the BIOS test mode.
3. Type "3" to select the "IP address change" setting.
4. Type "1" to select the first network interface, and then "1" again to change the local IP address.
5. Type the IP address you want to change.
6. Type "0" to return to the main menu, and then type "0" to start up the normal boot-up.

2.3 Installing the Required Software

The EN setup software is used to change the registers of the camera parameters, display live video images, and sniff hardware/trigger Ethernet from the lane controller. To install the software required for the TS-9720EN, run "Setup.exe" from the CD-ROM. This will guide you through the proper installation. Once the software is loaded on your system, find the "EN Setup" software from the Start menu (Start -> EN Setup -> EN Setup). If you are logging in for the first time, you must enter the following case-sensitive user name and password:

User Name: Administrator

Password: Password

Once you log in as Administrator, you can create a new user and set a custom password.

To set the properties of each camera connected to the network, follow the steps below:

1. Click the “Properties” button. The software will automatically find all EN cameras currently on the network.
2. Select the EN camera you want to see in the left window. All accessible registers are displayed in the right window.
3. Click the “Video” button. You can select the cameras in the left window in order to display either a live image, or a triggered image. You can display up to four cameras in a single screen.
4. Adjust the lens as needed.

3 Tutorial

This section demonstrates typical operations of the EN camera that most applications will require. This tutorial is intended for first-time users of the EN camera. Go through this section step by step to familiarize yourself with the EN's operations.

3.1 Image Capturing

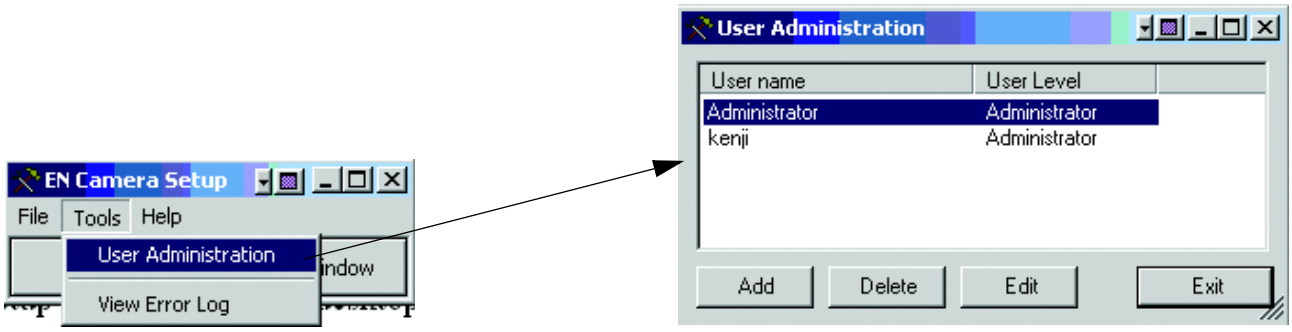
3.1.1 Start Up the EN Setup Software

Find the "EN Setup" shortcut on your desktop or go to "Start" -> "All Programs" -> "EN Setup" -> "EN Setup." Start the "EN Setup" software.

Type the case-sensitive user name "Administrator" and password "Password."

You can create a new user and password from User Administration option. From the "Tools" menu, select "User Administration," as shown in Figure 2 below.

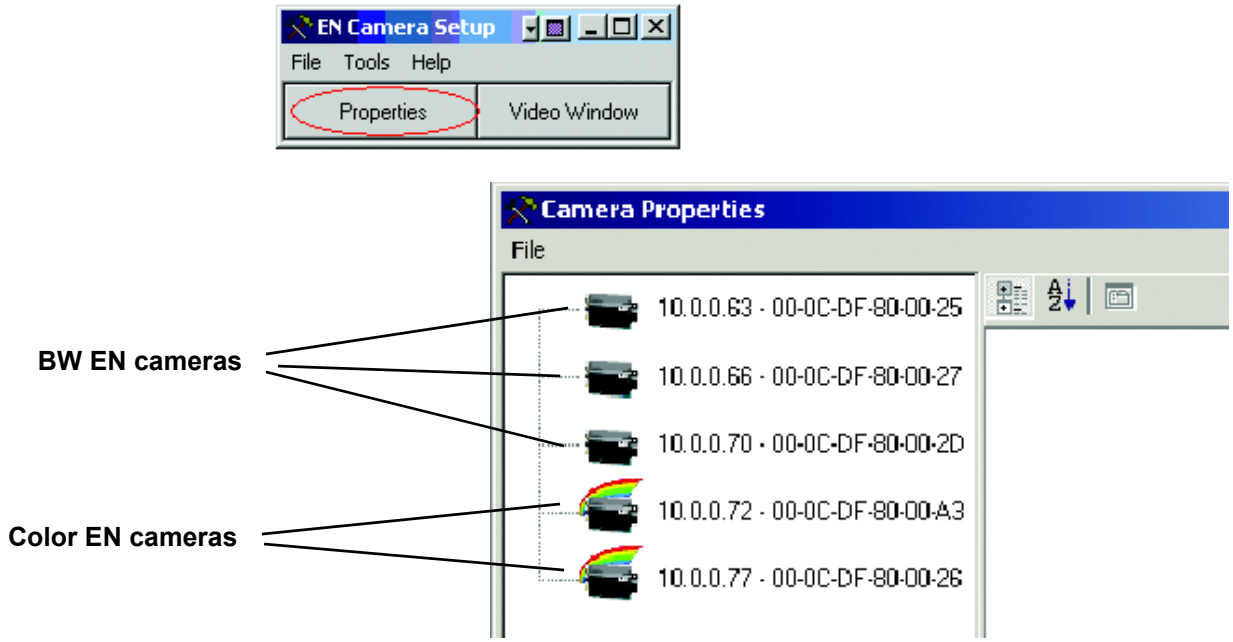
FIGURE 2. User Administration



Click the "Properties" button to see all the EN cameras that the software has found on your network.

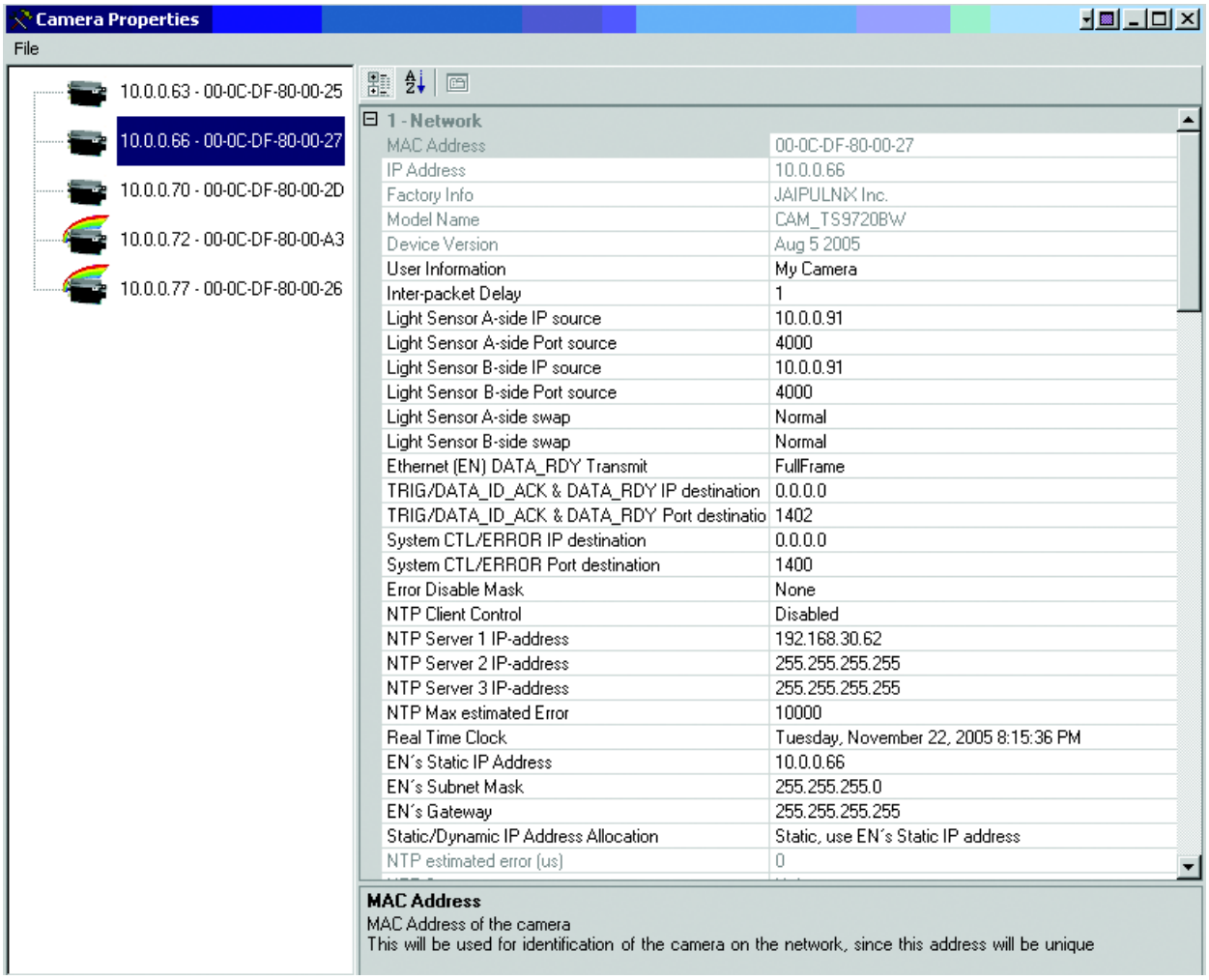
3.1.2 Camera Properties

FIGURE 3. **Properties**



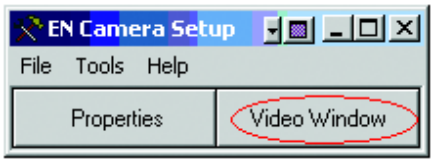
Click the camera icon on the left side of the window to see all the config/status registers accessible.

FIGURE 4. **Camera Properties**


Camera Properties
File
10.0.0.63 - 00-0C-DF-80-00-25
10.0.0.66 - 00-0C-DF-80-00-27
10.0.0.70 - 00-0C-DF-80-00-2D
10.0.0.72 - 00-0C-DF-80-00-A3
10.0.0.77 - 00-0C-DF-80-00-26
1 - Network
MAC Address 00-0C-DF-80-00-27
IP Address 10.0.0.66
Factory Info JAIPULNiX Inc.
Model Name CAM_TS9720BW
Device Version Aug 5 2005
User Information My Camera
Inter-packet Delay 1
Light Sensor A-side IP source 10.0.0.91
Light Sensor A-side Port source 4000
Light Sensor B-side IP source 10.0.0.91
Light Sensor B-side Port source 4000
Light Sensor A-side swap Normal
Light Sensor B-side swap Normal
Ethernet (EN) DATA_RDY Transmit FullFrame
TRIG/DATA_ID_ACK & DATA_RDY IP destination 0.0.0.0
TRIG/DATA_ID_ACK & DATA_RDY Port destinatio 1402
System CTL/ERROR IP destination 0.0.0.0
System CTL/ERROR Port destination 1400
Error Disable Mask None
NTP Client Control Disabled
NTP Server 1 IP-address 192.168.30.62
NTP Server 2 IP-address 255.255.255.255
NTP Server 3 IP-address 255.255.255.255
NTP Max estimated Error 10000
Real Time Clock Tuesday, November 22, 2005 8:15:36 PM
EN's Static IP Address 10.0.0.66
EN's Subnet Mask 255.255.255.0
EN's Gateway 255.255.255.255
Static/Dynamic IP Address Allocation Static, use EN's Static IP address
NTP estimated error (us) 0
MAC Address
MAC Address of the camera
This will be used for identification of the camera on the network, since this address will be unique

3.1.3 Live Image Capturing/Focusing

Click the "Video" button.

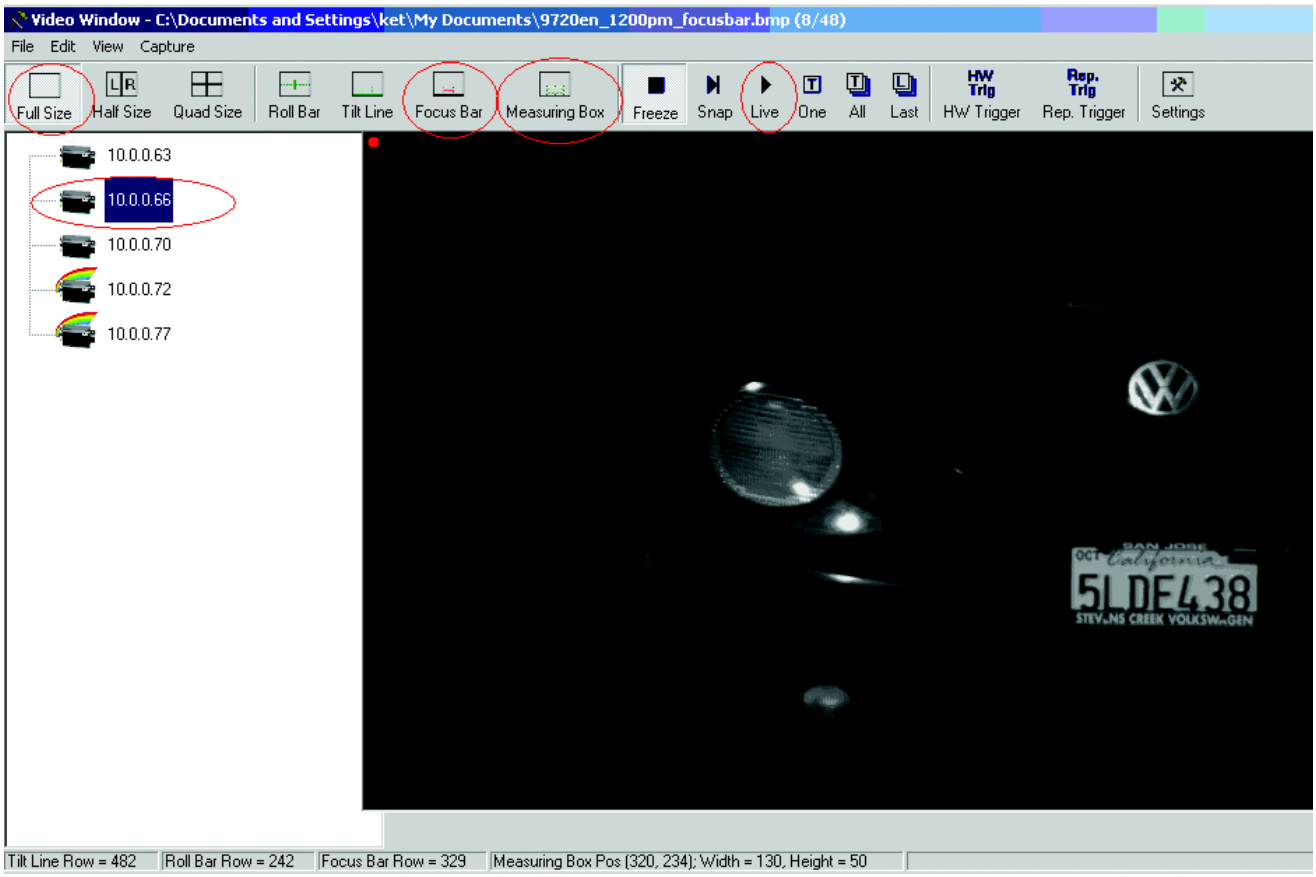


Highlight the icon of the camera you want to see. Click the "Full Size" and "Live" video buttons. You will now see a live video image. The live image is generated by an internal trigger mechanism inside the EN camera. This internal trigger is independent of either FTP or message-based TCP image. Also, during live image display, Flash is disabled at nighttime.

The "Snap" button captures only a single video image. The "Freeze" button disables the "Live" image option.

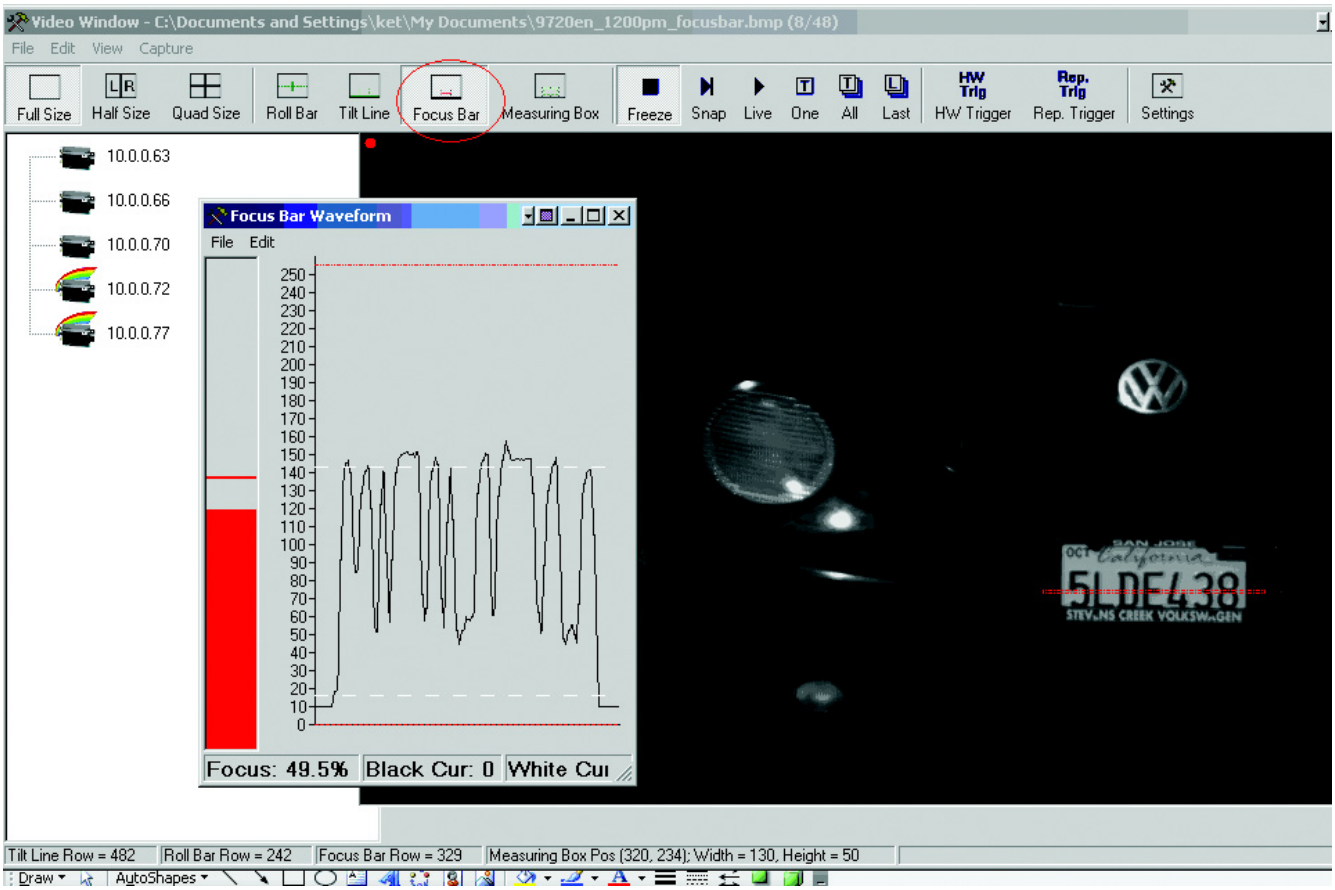
Use the "Live" or "Snap" buttons only while the camera is being set up, for when you want to see the maximum frame rate of the video image to focus the lens.

FIGURE 5. **Live Image Capturing**



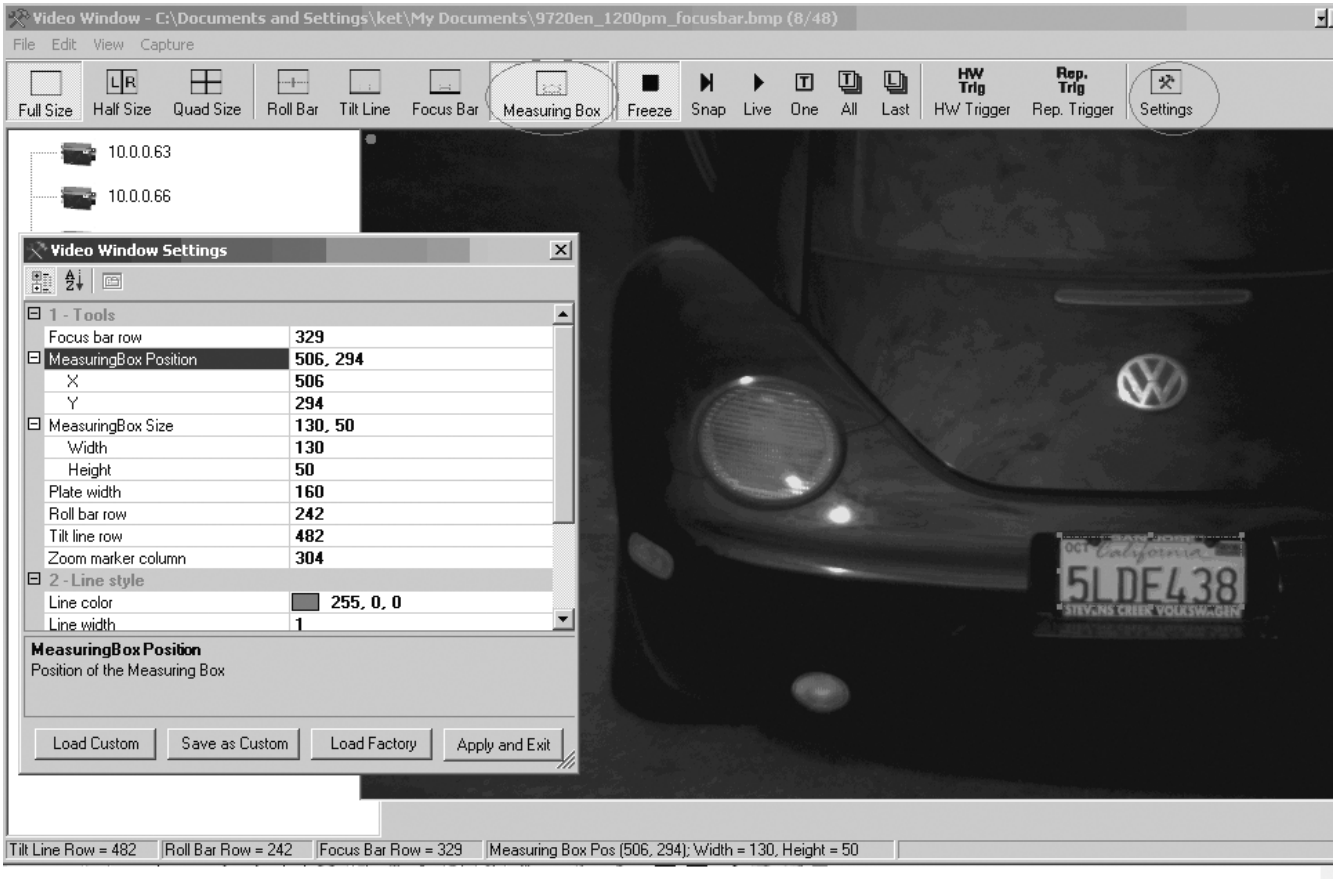
Use the “Focus Bar” button to make precise adjustments to the lens focus.

FIGURE 6. Focus Bar



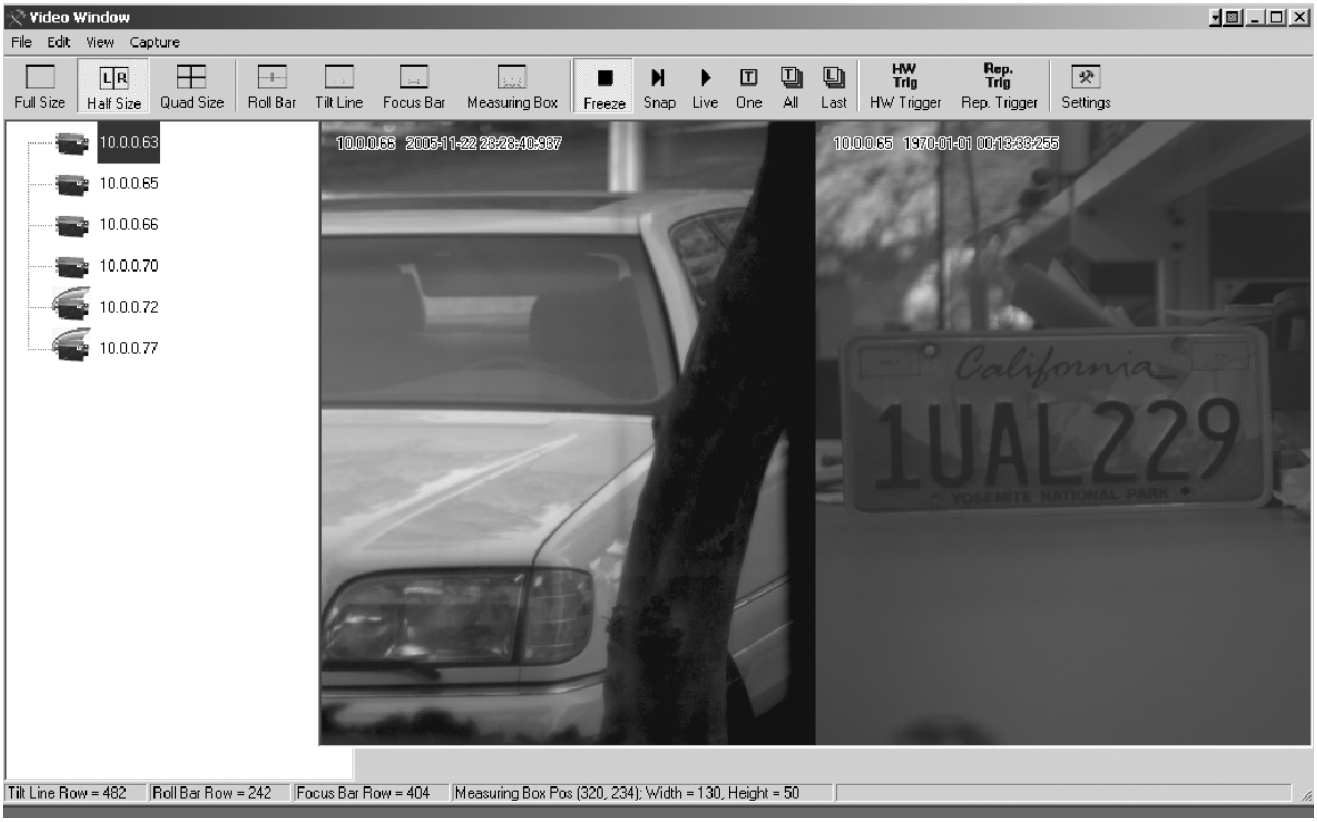
Use the “Measuring Box” button to make sure the license plate or particular target is in the correct side of the video field of view.

FIGURE 7. Measuring Box Position



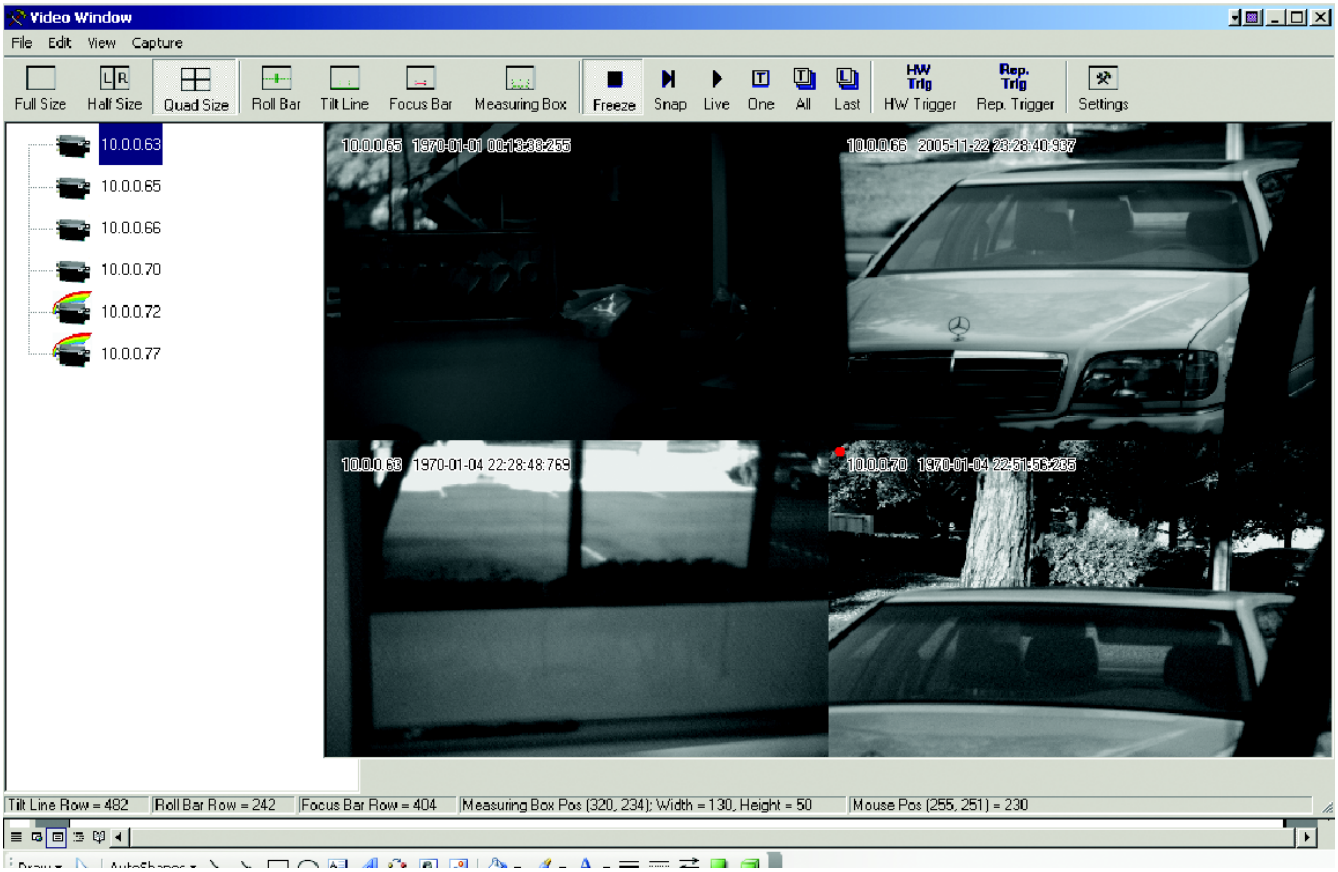
The “Half Size” image button is useful for situations in which two EN cameras together cover a single lane. Using the “Half Size” image button to capture two images: one on the left side of camera1, the other on the right side of camera2. To activate “Half Size,” click on the camera icon and drag it to either the left or right video frame. Click the “Live” button to see the live image. Use the focus tool to make precise adjustments to the lens focus.

FIGURE 8. Half Size Image Position



Click the “Quad Size” image button to capture four images. Each image will then be reduced from the full 768 x 484 resolution to 384 x 242 resolution. Click and drag the camera icon to the desired quad image frame. Click the “Live” button to see a live image.

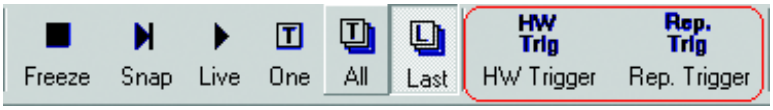
FIGURE 9. **"Quad Size" Image Button**



Three trigger-sniffing modes are available: "One," "All," and "Last." "One" trigger mode is for when you want the EN camera to take a single shot of video image, as soon as it receives a valid TTL trigger, Ethernet trigger, or RS-485 serial trigger. "All" trigger mode is continuous trigger-sniffing mode. Trigger sniffing is a mode of operation that allows the user to continuously and passively monitor images captured by the external trigger without disturbing the trigger process. For every trigger input, the EN camera will capture a new image. "Last" trigger mode is the same as "All" trigger mode, except that the EN camera will send the last captured image when you select the "All" button. Flash is activated when the trigger is received.

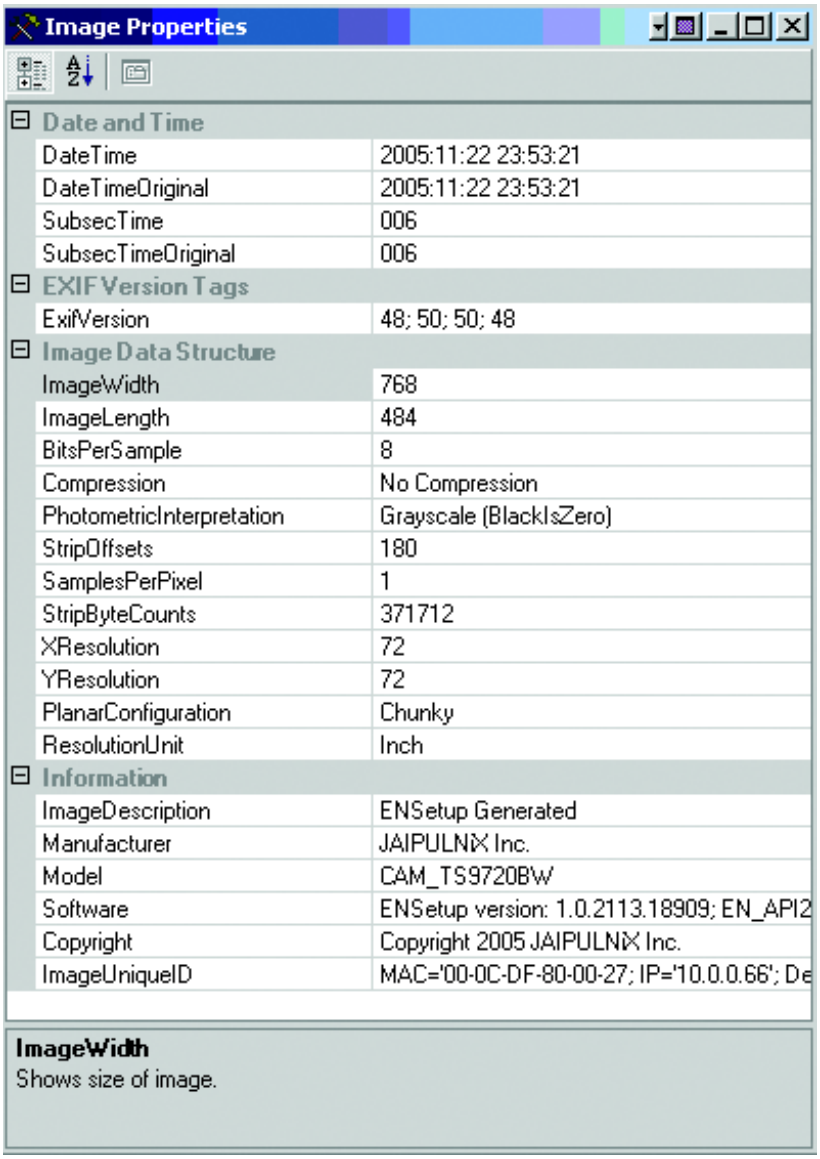
FIGURE 10. **Hardware Trigger Sniffing Mode**

The “HW Trigger” and “Rep. Trigger” buttons send the Ethernet trigger command to the EN camera. “HW Trigger” button sends a single Ethernet trigger command. “Rep. Trigger” sends a continuous Ethernet trigger command every second.



3.1.4 Image Properties

You can monitor the image properties of captured images, whether it’s “Live,” “Snap,” or “Trigger - Sniffing” mode. On the Video Window menu, select “Image Properties” under “View.” You can also use the EN setup software to monitor the image properties of saved images and FTP images.



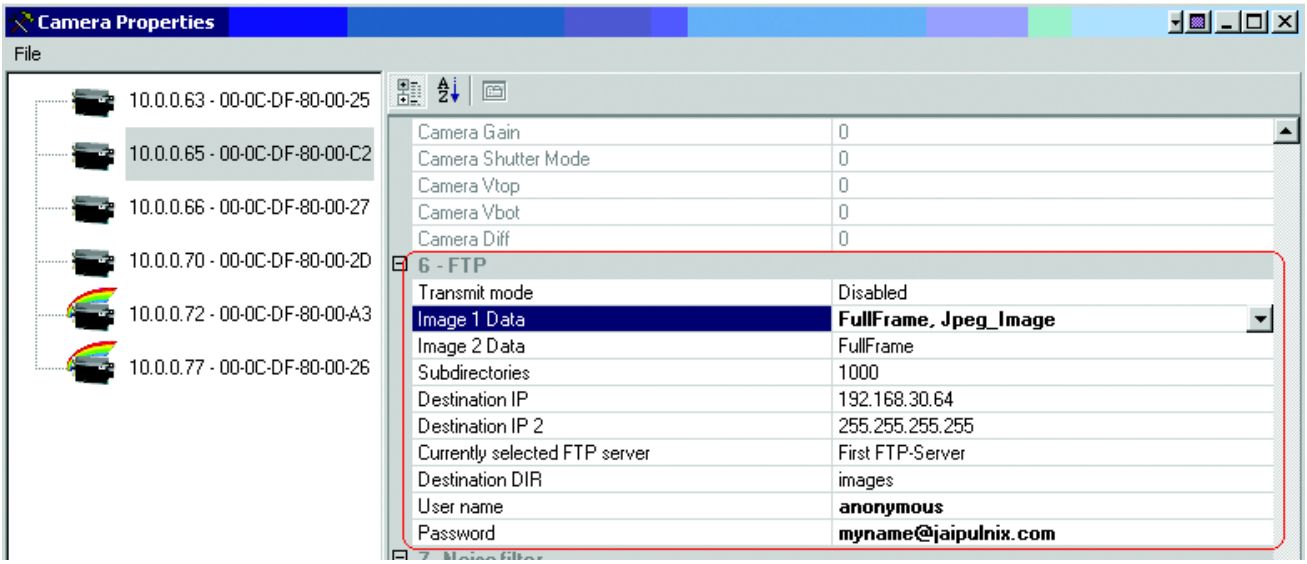
3.2 Image Transfer

3.2.1 FTP Image Transfer

To transfer images via FTP, first make sure to set up the FTP server properly. Please check the following items:

The username/password or anonymous login must be set for FTP server.

Set the permission of the read/write/create directory.



First, type the IP address of the FTP server (destination IP). If you have a second FTP server, enter that IP address as well. If the EN camera detects that the first FTP server is down, then it will automatically send images to the second FTP server.

Enter the User name and Password that the FTP server gives permission to.

Type image type (TIF or JPEG). “Image1 Data” is an image triggered by the first TTL trigger, Ethernet trigger, or RS-485 serial trigger. If the second FPGA trigger is set (Config Address=28), then the FPGA automatically generates the second hardware trigger predefined delay after the first hardware TTL trigger. “Image 2 Data” defines image type of the second triggered image. Normally, you should ignore the “Image 2 Data.”

“Subdirectories” is normally set to 1000. The EN creates subdirectories under a single Destination DIR. When the number of files in the subdirectory reach 1000, then the EN automatically creates another subdirectory. Naming conventions of the subdirectory can be found in the LC-to-EN interface document.

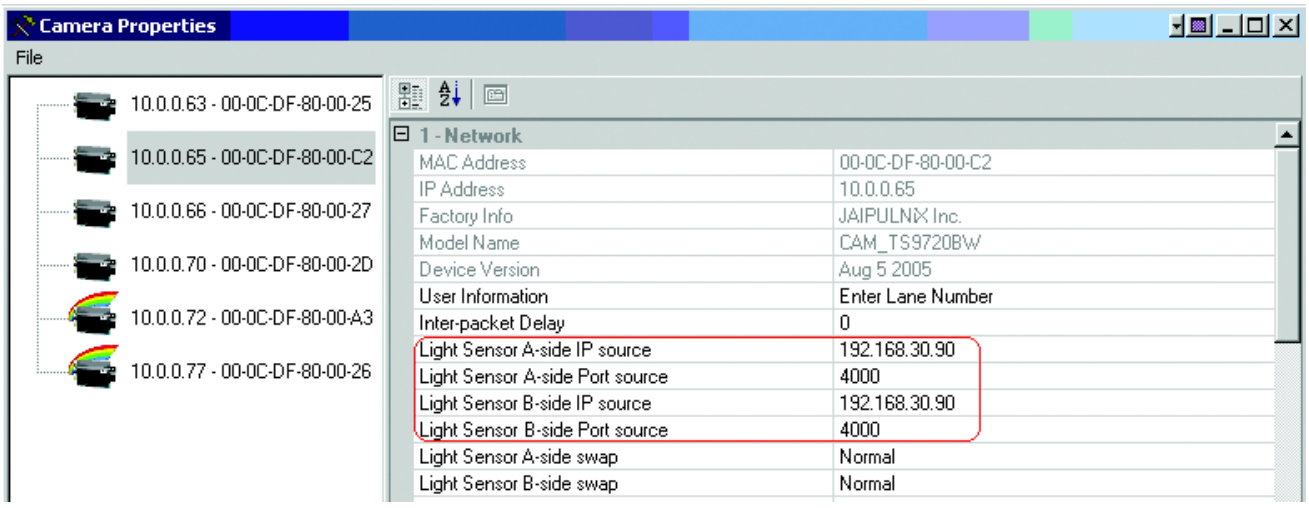
“Destination DIR” is a name of the directory where all “Subdirectories” are located.

3.3 ADR (Automatic Dynamic Range) Control

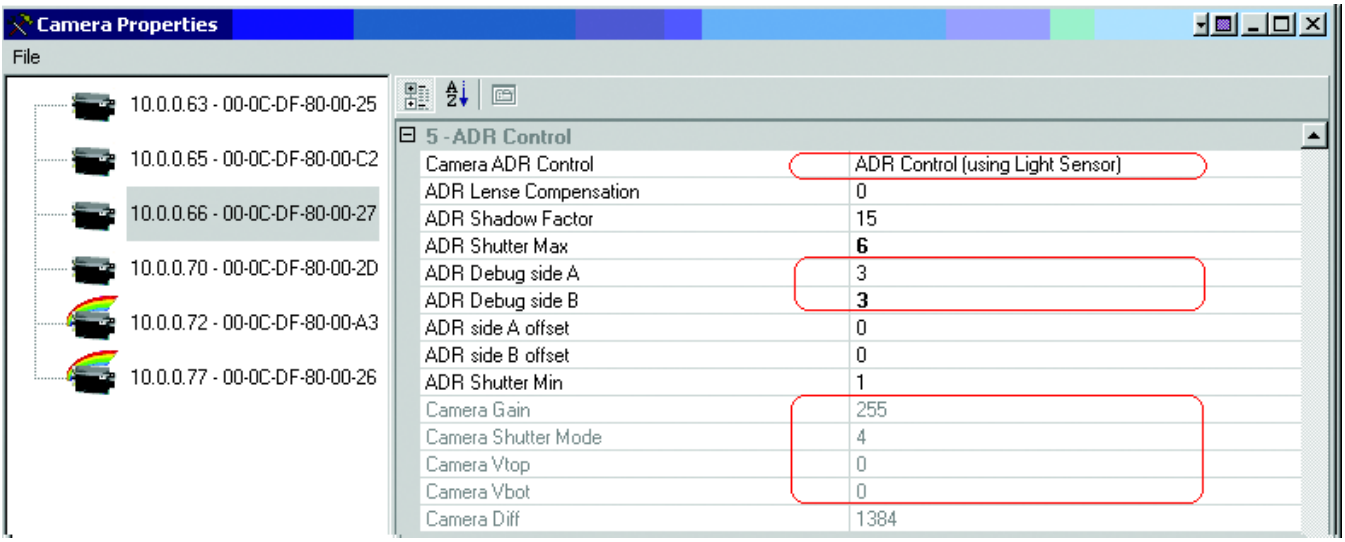
3.3.1 Light Sensor Connection

ADR control is a process that runs inside the EN camera. It controls the camera every 1/10 second to ensure that when the camera is triggered, it produces a high quality image of the license plate and the vehicle it is mounted on, in all ambient lighting conditions. The ADR also decides when to turn on/off auxiliary lighting as required to maintain proper plate illumination at night and during dawn/dusk transitions. ADR uses an external light sensor to provide the information required to operate properly. ADR operation can be enabled/disabled by the user at any time. Make sure to set up Moxa (RS-485 to Ethernet converter) properly. See (VIS300 manual Appendix A).

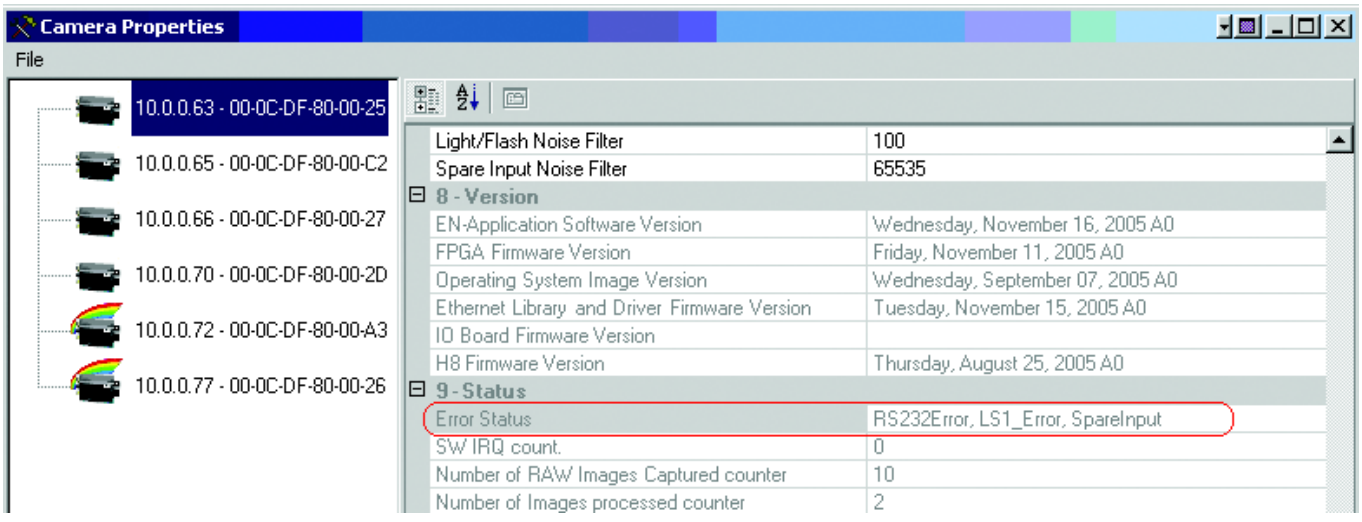
In the camera's "Properties" window, set up the light sensor's IP address and Port number. These numbers must be consistent with Moxa's setting.



You can connect up to two light sensors. If two IP addresses and port numbers are identical, then the EN camera tries to connect only a single light sensor.



Set the ADR Control register from “Manual” to “ADR Control (Using the Light Sensor).” This will activate the connection to the light sensor. If the connection is successful, you should see a live data change in the ADR Debug side A/B registers. Also, you should see what camera parameters ADR decides to set. In the above example, ADR sets to exposure time 4H (Dial 4 = 4H), Gain=255(max), Vtop=0, and Vbot=0. If there is a connection error, then these register values will all remain zero.



Also, check the “Error Status” register. If there is a connection error, LS1_ERR or LS2_ERR is set. If a light sensor is not required for your application, set the “Camera ADR Control” register to “Manual.”

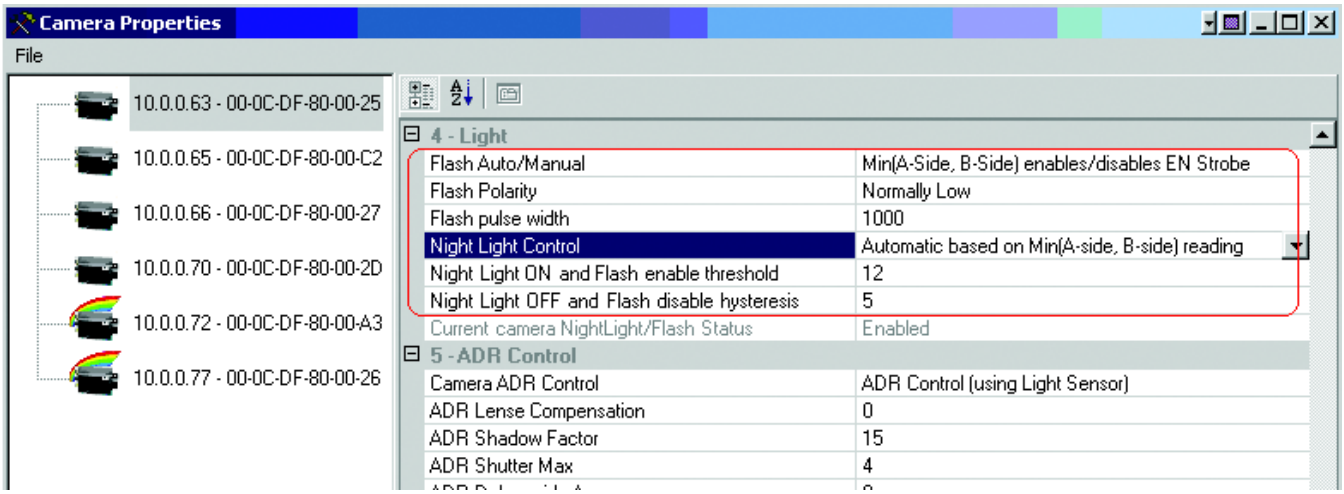
3.3.2 Flash Nighttime Light Control

The strobe and continuous nighttime light can be manually turned on and off. Set “Flash Auto/Manual” and “Night light Control” registers to Manual OFF or ON.

Generate an Ethernet trigger or input TTL trigger to see Flash. The “Live” or “Snap” button does not generate Flash, because they are independent from normal trigger operation.

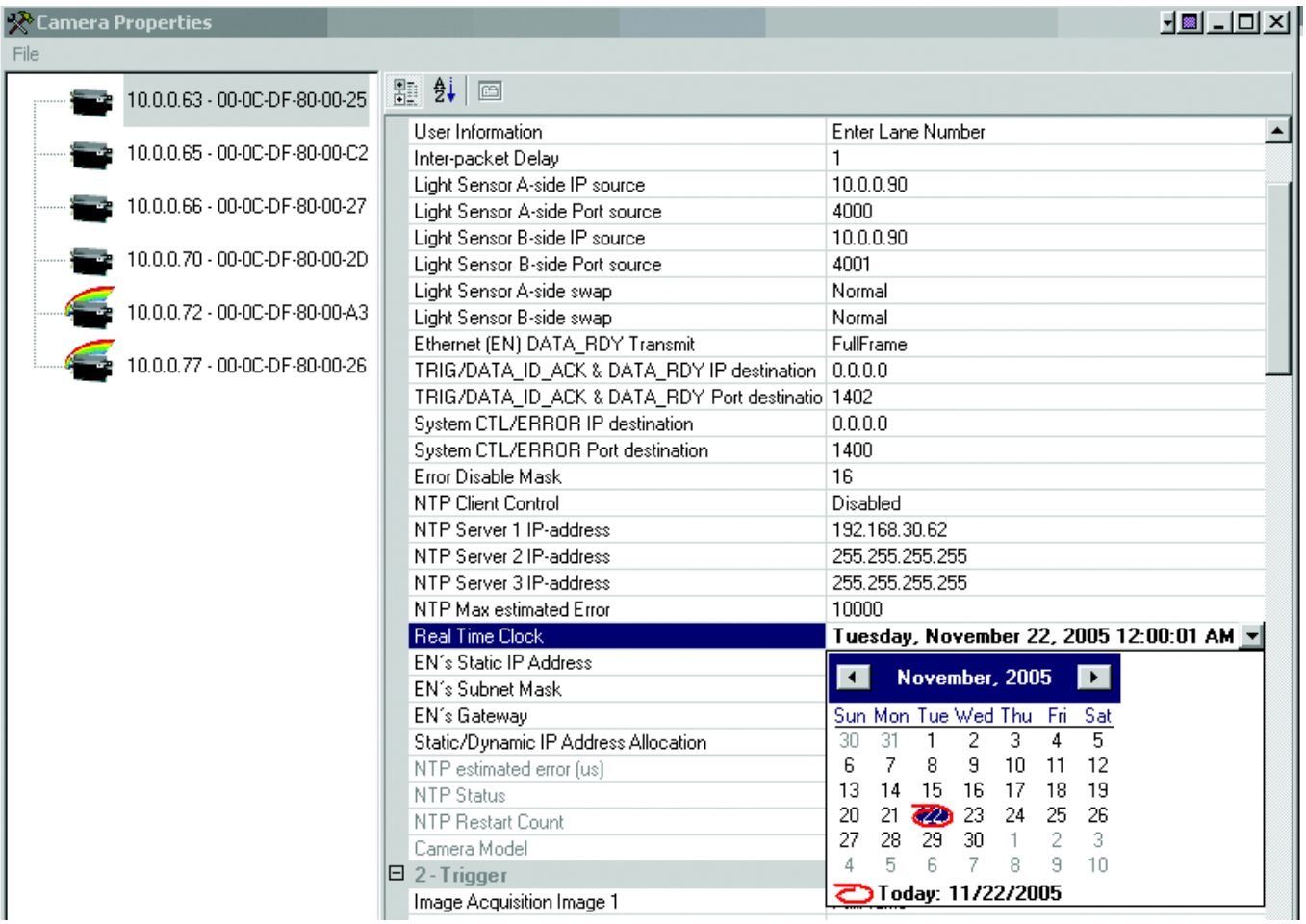
Normally, Flash and Night Light are controlled by ADR and a light sensor. To take advantage of this feature, connect to the light sensor. Set the “Flash Auto/Manual” and “Night Light Control” registers as shown below.

In this setting, in the evening when light sensor reading drops below 12, Flash and Night Light are turned on. And in the morning when the light sensor reading rises above 17, Flash and Night Light are turned off.



3.4 Time Synchronization

The EN camera supports NTP (network time protocol) synchronization. If you disable NTP by clearing the “NTP Client Control” register, then the internal clock will drift approximately 1.5 seconds per day. To reset the clock, set the “Real Time Clock” register to your current local time.



If you decide to take advantage of the NTP feature, make sure to set up the NTP server, preferably with GPS input. This guarantees that the clock drift is within 10ms. Set the NTP server IP-address registers up to 3 NTP servers. Then, enable “NTP Client Control” register. Reboot the camera.

After rebooting the camera, check the “Real Time Clock” register to check if the current time is properly set. Note that this time is GMT.

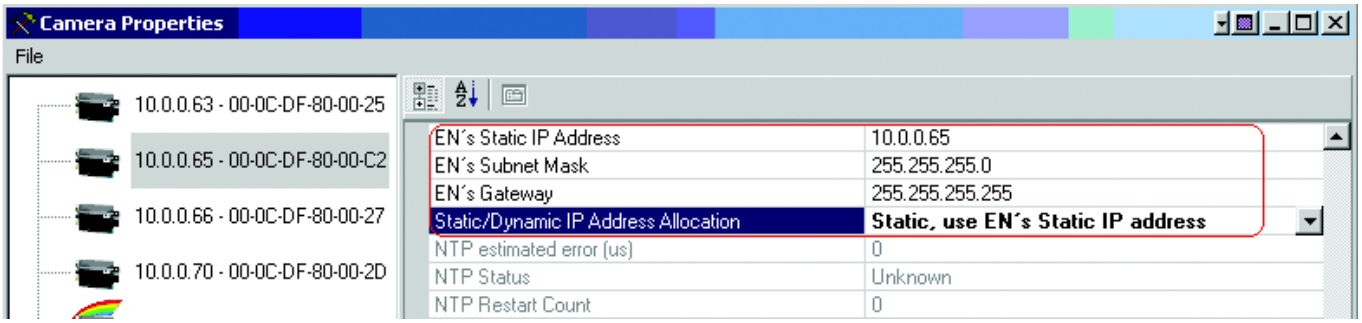
If the NTP drift file is empty, then the NTP will take about 1 hour to optimize the time. During the initialization, “NTP Status” must show USYNC, and “NTP estimated error” is max. After 3-4 hours, the time drift will become within 10ms. Check “NTP estimated error” and “NTP Status” registers again. “NTP Status” must be showing “PLL.” This means that NTP is finally synchronized properly.

3.5 Static IP Address Assignment

The factory default IP assignment is static IP= 10.0.0.65. The user must change the IP address of the camera. There are four methods to change the static IP address: EN setup software, Telnet,serial terminal using the debug RS-232 serial/power cable, and BIOS/Monitor using the debug RS-232 serial/power cable.

The first two options, EN setup software, and Telnet, require that the network settings of the EN camera such as IP address and Subnet Mask be known, while the last two options do not. If Ethernet is not available, then the last two options will be useful.

The EN setup software is the easiest way to change IP address. In the “Properties” window, change the network setting registers. After changing these registers, reboot the camera. The new setting appears at the next power-up.



- Telnet

  If you know the current IP address of the camera, you can telnet directly to the EN camera. Login as User name = root, Password = JAI PULNiX. If you want to assign a new IP address temporarily, you can use the “ifconfig” utility. If you want to assign a new IP address permanently, you can use the “test_libcamera” utility (See Section 3.6.3, “RS-232 PowerPC Debug Port,” on page 24).

- Serial terminal using the debug RS-232 serial/power cable.

  This is exactly the same as the previous “Telnet” solution, except that you do not need an Ethernet connection. If Ethernet is down, or if the IP of the camera is unknown, this method is useful. You can use “ifconfig” or “test_libcamera” utility to assign new IP address temporarily or permanently (See Section 3.6.3, “RS-232 PowerPC Debug Port,” on page 24).

- BIOS/monitor using Debug RS-232 Serial/Power cable.

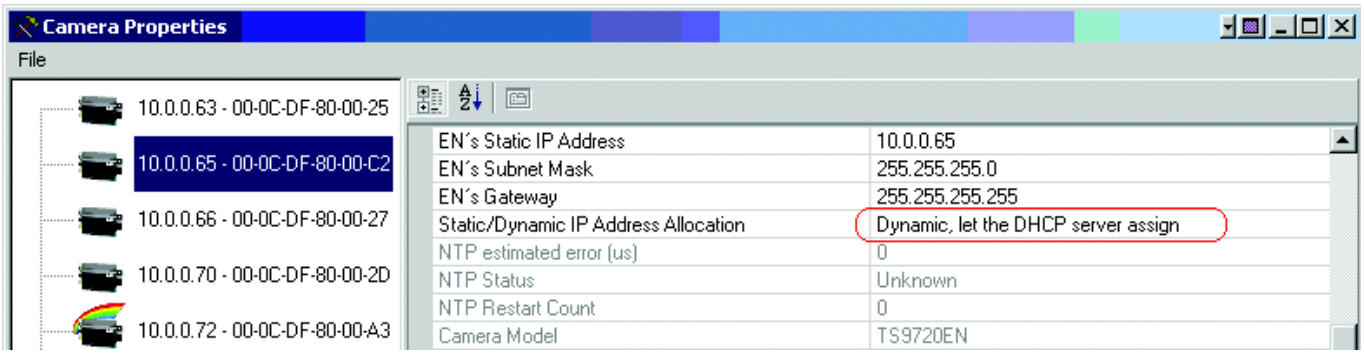
  The BIOS/monitor is an even lower level of software running underneath of OS and application code. By using the BIOS/monitor, you can assign a new IP address permanently. See Section 3.6.3, “RS-232 PowerPC Debug Port,” on page 24 for detailed operation.

3.5.1 DHCP Client

Make sure that you have a DHCP server in your network.

Change the “Static/Dynamic IP Address Allocation” register from “Static” to “Dynamic.”

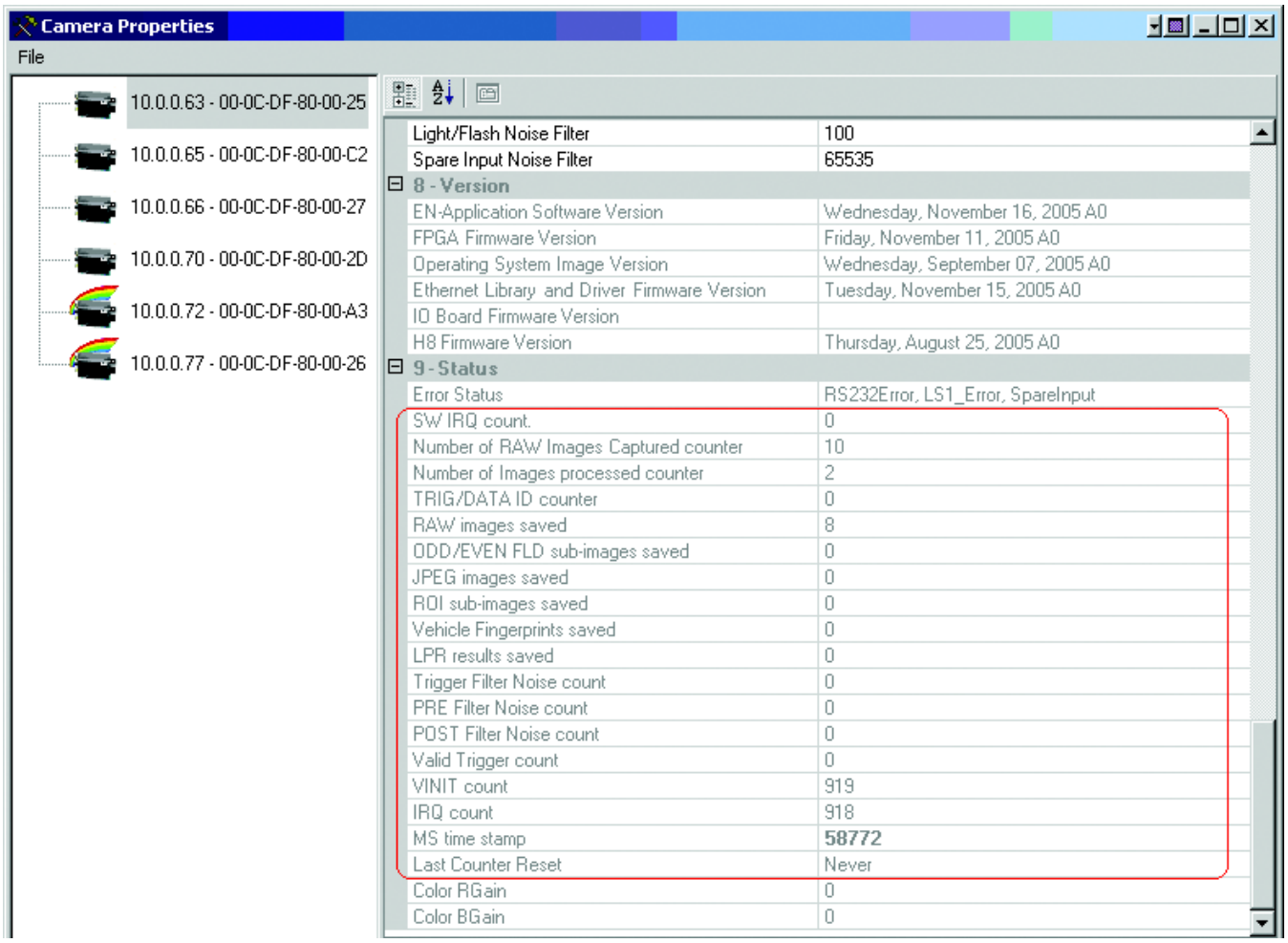
Reboot the camera. In the next power-up, the camera will get the IP address dynamically from the DHCP server.



3.6 Maintenance

3.6.1 Debug Counters

For debugging purposes, some status registers are available as debug counters.


Camera Properties
File
10.0.0.63 - 00-0C-DF-80-00-25
10.0.0.65 - 00-0C-DF-80-00-C2
10.0.0.66 - 00-0C-DF-80-00-27
10.0.0.70 - 00-0C-DF-80-00-2D
10.0.0.72 - 00-0C-DF-80-00-A3
10.0.0.77 - 00-0C-DF-80-00-26
Light/Flash Noise Filter 100
Spare Input Noise Filter 65535
8 - Version
EN-Application Software Version Wednesday, November 16, 2005 A0
FPGA Firmware Version Friday, November 11, 2005 A0
Operating System Image Version Wednesday, September 07, 2005 A0
Ethernet Library and Driver Firmware Version Tuesday, November 15, 2005 A0
IO Board Firmware Version
H8 Firmware Version Thursday, August 25, 2005 A0
9 - Status
Error Status RS232Error, LS1_Error, SpareInput
SW IRQ count. 0
Number of RAW Images Captured counter 10
Number of Images processed counter 2
TRIG/DATA ID counter 0
RAW images saved 8
ODD/EVEN FLD sub-images saved 0
JPEG images saved 0
ROI sub-images saved 0
Vehicle Fingerprints saved 0
LPR results saved 0
Trigger Filter Noise count 0
PRE Filter Noise count 0
POST Filter Noise count 0
Valid Trigger count 0
VINIT count 919
IRQ count 918
MS time stamp 58772
Last Counter Reset Never
Color RGain 0
Color BGain 0

Detailed information for each debugging counter is included in the LC-EN Interface document. This tutorial covers the following debug counters.

- Trigger Filter Noise count = number of hardware TTL triggers that failed trigger noise filter.
- PRE Filter Noise count = number of hardware TTL triggers that failed PRE filter.
- POST Filter Noise count = number of hardware TTL triggers that failed POST filter.
- Valid Trigger count = number of hardware TTL triggers that passed noise filter, PRE filter, and POST filter.
- VINIT count = number of reset signals sent to CCD
- IRQ count = number of interrupt generated by FPGA to PowerPC

By generating an Ethernet trigger ("All" and "HW Trigger" button on the EN setup video window), you can see only VINIT and IRQ counters are incrementing. This is because the first four counters are only for the hardware TTL trigger.

By feeding the hardware TTL trigger, you can see "Valid Trigger count," "VINIT count" and "IRQ count" register incrementing.

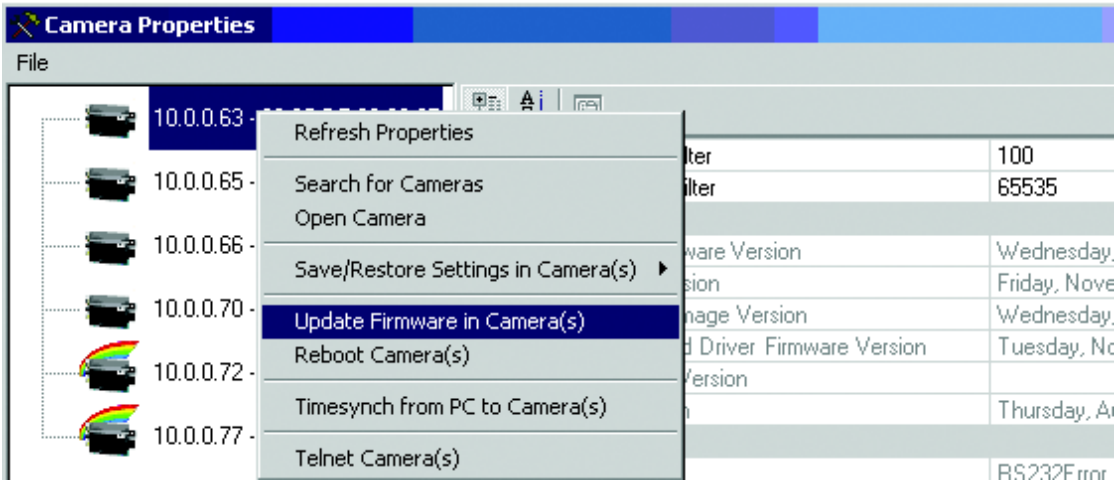
If you set 1ms to "Trigger Filter Noise" register and the hardware TTL trigger pulse is less than 1ms, then the trigger is ignored as an invalid signal. Only "Trigger Filter Noise count" must be incremented. However, all other counters remain the same.

If you set the PRE trigger filter to 10ms but the TTL trigger has only 9ms stable PRE condition, then only "PRE Filter Noise count" must be incremented. However, all other counters remain the same.

If you set the POST trigger filter to 10ms but the TTL trigger has only 9ms stable POST condition, then the "POST Filter Noise count" must be incremented. Unlike PRE trigger, "VINIT count" is also incremented, because trigger pulse is sent to CCD anyway before finishing validation of POST condition. Once FPGA invalidates the POST condition, FPGA does not generate IRQ to PowerPC. Besides "POST Filter Noise count" and "VINIT count," all other counters remain the same.

3.6.2 Firmware Upgrade

In the "Properties" window, right-click on the camera icon you want to upgrade. Select "Update Firmware in Camera(s)."



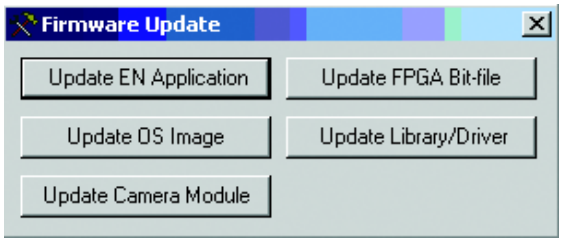
You can update the five pieces of firmware inside the EN camera. Each piece of firmware has a distinctive extension.

TABLE 1. Firmware Names and Descriptions

Firmware Name	Description	Filename conversion
EN Application	Top-level application	en_YYMMDDVR.app
FPGA Bit file	FPGA firmware	xc2s200e_YYMMDDVR.bit

TABLE 1. **Firmware Names and Descriptions (Continued)**

Firmware Name	Description	Filename conversion
OS Image	Real-time Linux OS image	vmlinux_YYMMDDVR.osi
Lib/Drv file	Library and driver package	libdrv_YYMMDDVR.drv
Camera Module	H8 firmware	h8cpu_YYMMDDVR.pat

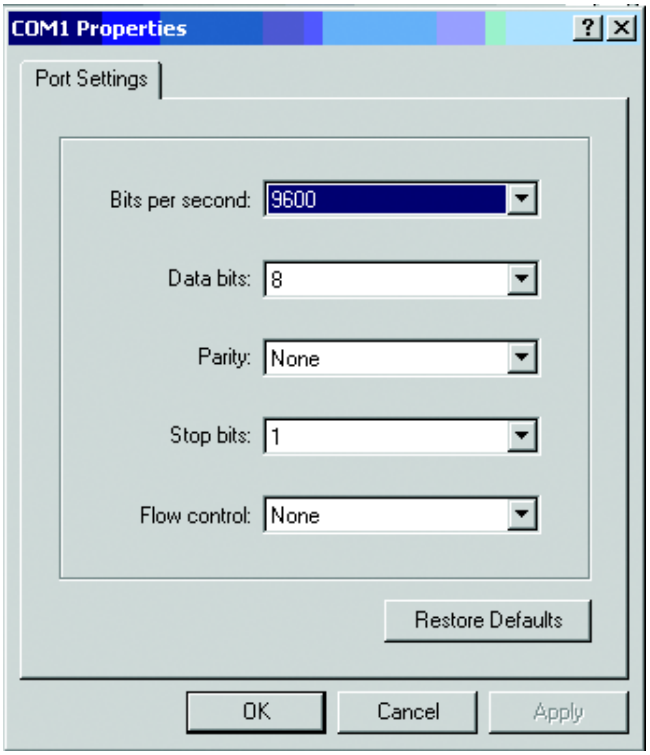


If you want to update multiple cameras at the same time, use the SHIFT key to highlight multiple cameras. Then, right-click to select “Update Firmware in Camera(s).”

3.6.3 RS-232 PowerPC Debug Port

If you have the debug RS-232 serial/power cable, you can debug EN cameras over the serial port. This is useful when Ethernet is not available. In this tutorial, we suppose we have accidentally assigned an invalid IP address to the EN camera, and now we cannot communicate with the EN camera over Ethernet. When this happens, there are two recovery methods.

The first method requires setting the Hyperterminal to the following setting (9600-8-N-1. No hardware handshake).



Power up the EN camera. You should see the monitor message in the serial terminal. Type the "/" key within three seconds.

```
JAIPULNiX 405GPr ROM Monitor

Version 1.2.4 July 11th, 2005
Found Factory FPGA bitfile.
Now booting up FPGA from FlashROM in Factory Bitfile mode.
PROGRAM_N bit is asserted
INIT_N bit is pulled low
PROGRAM_N bit is deasserted
INIT_N bit is pulled high
DONE_N bit is pulled high
FPGA boot-up successfully done
Press / key to start monitor
_
```

After typing the "/" key, you should see the following monitor menu.

```
----------------------------
Debugger: Disabled
----------------------------
 1 - Enable/disable tests
 2 - Enable/disable boot devices
 3 - Change IP addresses
 4 - Ping test
 5 - Toggle ROM monitor debugger
 6 - Toggle automatic menu
 7 - Display configuration
 8 - Save changes to configuration
 A - Enable/disable I cache (Enabled )
 B - Enable/disable D cache (Enabled )
 M - Memory Test
 U - OS Image BootUp Option
 Z - Set ethernet HW address
 0 - Exit menu and continue
->_
```

Enter "3" to select "Change IP addresses" mode.

```
->3
---   CHANGE IP ADDRESS   ---
 Device List:
   001  Enabled   Ethernet      [ENET]
                  local=10.0.0.65  remote=255.255.255.255  hwaddr=000cdf8000c2
 ----------------------------
select device to change ->1_
```

Enter "1" to select Ethernet interface 1.

Enter "1" again to select "Change local address."

Enter the new IP address.

```
select device to change ->1
  1 - Change local address
  2 - Change remote address
  0 - Return to main menu
->1
Current IP address = (10.0.0.65)
Enter new IP address ->Enter IP address in dot notation, (eg. 8.1.1.2)
10.0.0.69
```

After setting the new IP address, type "0" to exit the monitor menu.

After the boot-up sequence, login to the serial terminal. (Username = root, Password = JAIPULNiX)

Type “en -v > version.txt.” View the content of “version.txt” to see the firmware version.

```
# en -v > version.txt
camera driver is being opened
camera driver is being closed!
# cat version.txt
Welcome to JAI-PULNiX EN Camera
EN version   : 051115A2
OS version   : 050907A0
LIB version  : 051021A0
FPGA version : 050805C0
#
```

Enter the command “ps” to see what processes are running. If the “dhcpc” daemon is running, kill this process. To do so, enter, for example, “kill <process_id>.”

Enter the command “ifconfig” to see if the network is up and running.

```
# ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0C:DF:80:00:C2
          inet addr:10.0.0.65  Bcast:10.255.255.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:7826 errors:0 dropped:0 overruns:0 frame:0
          TX packets:582390 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          RX bytes:532835 (520.3 kb)  TX bytes:869733477 (829.4 Mb)
          Interrupt:15

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
```

Eth0 is the network interface of the EN camera. In the above example, the EN’s network is set to the following: IP address = 10.0.0.65. Subnet mask = 255.255.255.0.

If eth0 is not running or if you want to change to a different IP address, you can set the temporary network setting just to enable a FTP, TELNET, or Ethernet connection.

Enter the command “ifconfig eth0 <NEW IP ADDRESS> netmask <SUBNET MASK>.” This is a temporary IP assignment because the EN camera will lose this setting once you restart it.

```
# ifconfig eth0 10.0.0.89 netmask 255.255.255.0
# ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0C:DF:80:00:C2
          inet addr:10.0.0.89  Bcast:10.255.255.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:7912 errors:0 dropped:0 overruns:0 frame:0
          TX packets:582431 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          RX bytes:539339 (526.6 kb)  TX bytes:869736191 (829.4 Mb)
          Interrupt:15

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
```

Now you should be able to telnet to the EN cameras.

If you want to assign the new IP address permanently, you can use the “test_libcamera” utility. The “test_libcamera” utility allows access to EEPROM, where all network settings are saved. After starting “test_libcamera,” you can use the following commands:

rc : read IP assignment (static or dhcp) wc : write IP assignment

rp : read IP addresss wp : write IP address

rs : read Subnet mask ws : write Subnet mask

rg : read Gateway wg : write Gateway

Change the IP assignment/IP address/SubnetMask/Gateway. Reboot the camera. The new IP address/ subnet mask are used at the next power-up.

4 Uploading the Firmware

There are five pieces of firmware inside the EN camera that you can upload over the Ethernet. They are:

EN_APP:	top-level application software.
OS_Image:	Linux OS image and basic tile system
Lib/drV:	library and driver file package
FPGA Bitfile:	FPGA firmware
H8:	H8 firmware. H8 is responsible for serial communication to the CCD camera module and Gamma LUT.

4.1 To Verify Version Numbers for all Firmware

You can verify the version numbers of all firmware by using the RS-232 PPC debug serial port/telnet or the EN setup software. Both methods are explained below.

4.1.1 RS-232 PPC Debug Serial Port/Telnet

To verify the version numbers of all firmware with the RS-232 PPC debug serial port/telnet, login to EN camera as ROOT with the following user name and password:

user name: root
password: JAIPULNiX

Type “en-v” to see the version numbers for all firmware currently running.

Ex:

```
#en-v > version.txt
#more version.txt
Welcome to JAI-PULNiX EN Camera
EN version                  : 050812A0
OS version                  : 050810A0
Lib/drv version             : 050812A0
FPGA version                : 050805C0
```

4.1.2 EN Setup Software

To verify version numbers for all firmware using the EN setup software, follow the steps below:

1. Start the EN setup software.
2. Click the “Properties” button.
3. Search for cameras in the network.
4. Left-mouse click on the camera you want.
5. Find the version numbers.

4.2 Updating the EN Application Software

The EN setup software is used to update the EN application software. The method is described below.

1. Start the EN setup software.
2. Click the “Properties” button.
3. Right-click on the camera, and select “Update Firmware.”
4. Select “Update EN Application.”
5. Reboot the EN camera for the updates to take effect.

Note: You cannot update the identical EN application version.

4.3 Updating the FPGA Bitfile

You can update the FPGA bitfile by using the EN setup software. To do so, follow the steps below.

1. Start the EN setup software.
2. Click the “Properties” button.
3. Right-click on the camera, and select “Update Firmware.”
4. Select “Update FPGA Bit-file.”
5. Reboot the EN camera.

4.4 Updating the Lib/Drv File

You can update the Lib/Driv file by using the EN setup software. To do so, follow the steps below.

1. Start the EN setup software.
2. Click the “Properties” button.
3. Right-click on the camera and select “Update Firmware.”
4. Select “Update Library/Driver.”
5. Reboot the EN camera.

4.5 Updating the OS Image

You can update the OS image by using the EN setup software. To do so, follow the steps below.

1. Start the EN setup software.
2. Click the “Properties” button.
3. Right-click on the camera and select “Update Firmware.”
4. Select “Update OS Image.”
5. Reboot the EN camera.

4.6 Updating the Camera’s H8 Firmware

You can update the camera’s firmware using the EN setup software. To do so, follow the steps below.

1. Start the EN setup software.
2. Click the “Properties” button.
3. Right-click on the camera, and select “Update Firmware.”

4. Select “Update H8.”
5. Reboot the EN camera for the changes to take effect.

4.7 Updating the Firmware Manually When the Network is Down

It is sometimes necessary to update the firmware by hand when you do not have access to the network. This can happen, for example, if you have forgotten the IP address of the camera or when the update via the network fails. To update the firmware by hand, follow the steps below. You will need to use the RS-232 serial cable and the power/serial debug cable.

1. Log-in (user=root, password=JAIPULNiX) and change the directory to /usr/local/bin.
2. Type “ps” to see the process running. Kill the “dhcpcd” process, if it is running in the background.
3. Assign a static IP address to the network interface.

   Example: To assign a static IP=10.0.0.65 and subnetmask =255.255.255.0, enter the following command:

   ifconfig eth0 10.0.0.65 netmask 255.255.255.0
4. Via FTP, manually send the firmware file to the /usr/local/bin directory of the EN camera.
5. Run test_bcs utility.

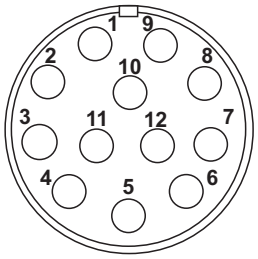
   Ex.test_bcs –a en_YYMMDDVR.app Update EN App file
   test_bcs -b xc2s200e_YYMMDDVR.bin Update FPGA bitfile
   test_bcs -l libdrv_YYMMDDVR.drv Update Lib/Drv file
   test_bcs -o vmlinuz_YYMMDDVR.osi Update OS image
6. Reboot the EN camera (command “reboot”). The new firmware is loaded at the next power-up.

5 Connectors and Cables

5.1 Connector Pin Configurations

5.1.1 12-Pin Connector

FIGURE 11. 12-Pin Connector



The TS-9720EN has a 12-pin Hirose connector for power input, serial communication, and signal integration. Pin #1 is Ground and Pin #2 is +12V DC. Other pins handle a number of input and output functions, as shown in Table 2 below.

TABLE 2. 12-Pin Connector

Pin	Description	Pin	Description
1	GND (power)	7	Reserved
2	+12V DC	8	Flash strobe output
3	GND (analog)	9	Reserved
4	Test point	10	RXD (RS-232) PowerPC debug port
5	GND (digital)	11	Reserved
6	Trigger input	12	TXD (RS-232) PowerPC debug port

5.1.2 High-Density 26-Pin D-Sub Connector

The TS-9720EN has a 26-pin MDR26 connector (3M part number 10226-6212VC) on the rear panel. The connector pin-out is shown in Table 3 below.

FIGURE 12. 26-Pin HD-Sub Connector

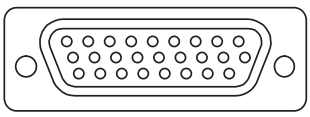


TABLE 3. D-Sub Connector Pinout Configurations (10226-6212 VC)

High-Density 26-Pin D-Sub Connector (Female)					
Pin #	**Description**	**I/O**	**Pin #**	**Description**	**I/O**
1	GND (Power)		14	Tamper Input	In
2	+12V Input	Out	15	Reserved	Out
3	RxD for Laser Detector (TTL)	In	16	LVD / IO Selector	Out
4	TxD for Laser Detector (TTL)	Out	17	Ethernet D+ (spare)	-
5	DIR Control for Laser Detector (TTL)	Out	18	Ethernet A-	Out

TABLE 3. D-Sub Connector Pinout Configurations (10226-6212 VC) (Continued)

High-Density 26-Pin D-Sub Connector (Female)					
Pin #	**Description**	**I/O**	**Pin #**	**Description**	**I/O**
6	Ethernet C+ (spare)	-	19	GND (Analog)	Out
7	Ethernet C- (spare)	-	20	Test point	Out
8	Ethernet B-	In	21	Trigger Input	Out
9	Ethernet B+	In	22	LC TxD (TTL)	In
10	GND (Digital)	Out	23	LC RxD (TTL)	In
11	Flash Strobe Output	Out	24	LC DIR Control (TTL)	In
12	Flash Status Input	In	25	Ethernet D- (spare)	-
13	IO Status Change	In	26	Ethernet A+	Out

5.1.3 10/100 BaseT Ethernet

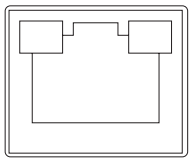
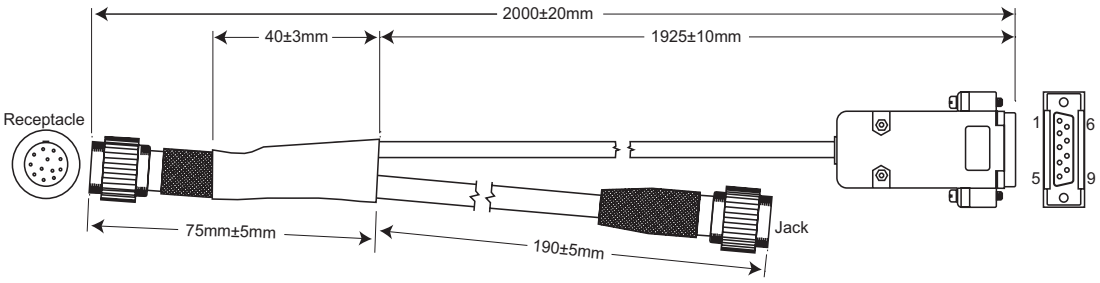


TABLE 4. 10/100 BaseT Ethernet Pinout Configuration

10/100 BaseT Ethernet Pinout Configuration			
1	Ethernet TxD A+	5	N/C
2	Ethernet TxD A-	6	Ethernet RxD B-
3	Ethernet RxD B+	7	N/C
4	N/C	8	N/C

5.2 RS-232 Communication Cable

FIGURE 13. Serial Communication Cable RS-232B-12 (JAI PULNiX part number: 310 132 19)



The RS-232B-12 interface cable is used to debug the PowerPC processor. This debug port is useful when the network is down and RS-232 is the only choice to connect with the EN camera. See Section 3.6.3 on page 24 and Section 4.7 on page 31 for detailed information on how to use the debug PowerPC port.

5.3 Power Supplies and Power Cable Setup

5.3.1 Power Supplies

The TS-9720EN requires 12V DC power that is obtained through the 12-pin connector located on the rear panel of the camera. JAI PULNiX recommends the following power supplies:

PD-12UU	100-240V AC/12V DC	1.2A universal voltage power supply with US plug
PD-12UUP	100-240V AC	1.2A universal voltage power supply with US plug and 12-pin connector
PD-12UE	100-240V AC/12V DC	1.2A universal power supply with European plug
PD-12UEP	100-240V AC/12V DC	1.2A universal power supply with European plug and 12-pin connector

If you are providing power through the 12-pin connector, the PD-12UUP and PD-12UEP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12UU or PD-12UE power supply can be connected to the JAI PULNiX power cable either directly or via a terminal strip.

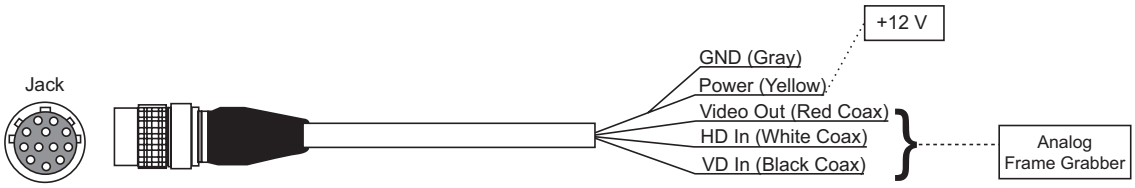
When wiring the PD-12UU power supply directly, please note the following:

- The lead ends must be twisted together and tin-soldered for strength and electrical continuity.
- Shrink tubing or a similar insulator should be used to prevent exposed leads from touching and shorting.
- The +12V lead is marked with a red stripe or white lettering; be sure not to reverse the leads.
- All connections must be properly insulated to prevent shorting.

5.3.2 JAI PULNiX Power Cables

If you are using JAI PULNiX power cables such as the 12P-02S, please refer to the 12-pin connector pin-out diagram in “12-Pin Connector” on page 32. The cable pin-out diagram is shown in Figure 14 below. The color-coded leads use Gray for Ground and Yellow for +12V.

FIGURE 14. 12P-02S Interface Cable (optional)



12P-02S Interface Cable					
Pin#	**Lead Color**	**Function**	**Pin#**	**Lead Color**	**Function**
1	Gray	GND	7	Black coax	Reserved
2	Yellow	+12V DC	8	White coax shield	Reserved
3	Red coax shield	GND	9	White coax	Reserved
4	Red coax	Video	10	Brown	RXD
5	Orange coax shield	GND	11	Blue	Reserved
6	Orange coax	VINIT IN	12	Black coax shield	TXD

Note: *Make sure that the unused leads are not touching and that there is no possibility that exposed wires could cause the leads to short.*

5.3.3 Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Section 5.1.1 on page 32. Connect the Ground lead to pin #1, and the +12V DC lead to pin #2 of the 12-pin connector. Power must be DC-regulated, and of sufficient current to properly power the camera.

5.3.4 Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will only fit in one orientation. Follow these directions to properly attach the power cable to the camera connector:

1. Rotate the connector while applying slight pressure until the keyways line up.
2. Press the connector into place until firmly seated.
3. Plug the power cord into the AC socket. This will power the camera up.

5.4 Attaching the Camera Lens

The TS-9720EN camera accepts 2/3" or larger format size C-mount lenses. To attach the C-mount lens to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly. Please note that some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

6 Camera Features

6.1 Progressive scanning

Standard TV-system scanning is 525 lines interlace scanning as specified in the RS-170 protocol. Every other horizontal line (odd lines and even lines) is scanned at a 60Hz rate per field, and the scanning is completed with two fields (one frame) at 30Hz rate. Because of the interlace scanning, the vertical resolution of CCD cameras is limited at 350 TV lines, regardless of the horizontal resolution. When electronic shutter is applied, the CCD can hold only one field of charge at each exposure. Therefore, the vertical resolution of the electronic-shutter camera is only 244 TV lines. The situation is the same for an HDTV-format camera, since it has interlaced scanning and the vertical resolution of the shuttered image is 500 lines.

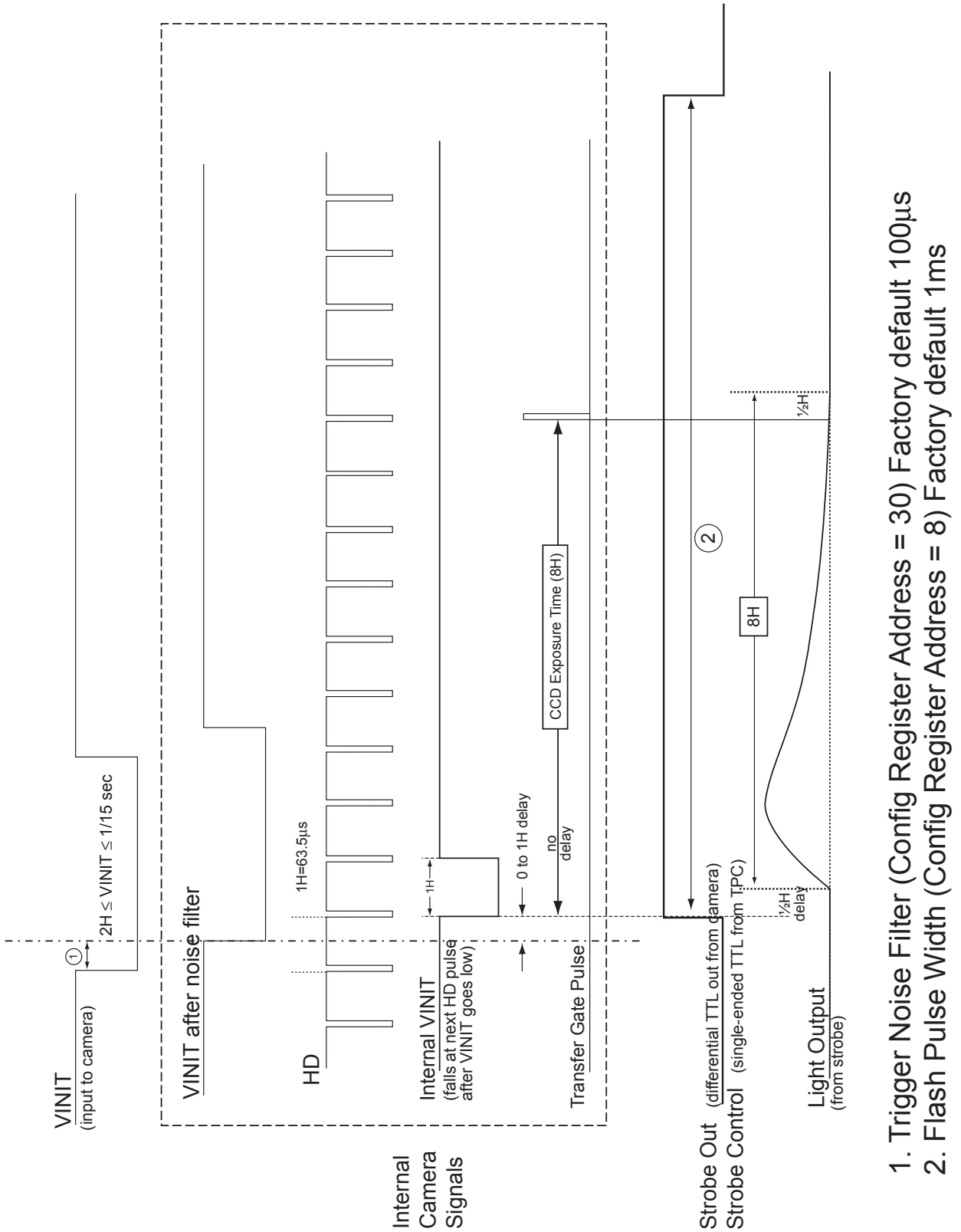
The TS-9720EN uses a state-of-the-art progressive scanning interline transfer CCD which scans all lines sequentially from top to bottom at one frame rate (30Hz). Line a non-interlace computer screen, it generates a stable, crisp image without alternating lines and provides full vertical TV resolution of 525 lines.

The interline transfer architecture is also important to generate simultaneous shuttering. This is different from full frame transfer architecture which requires a mechanical shutter or strobe light in order to freeze the object motion.

6.2 Asynchronous Reset

The video signal starts with internal VD. When the external VINIT pulse is applied, internal VD is latched to HD and the internal VD is delayed to set up the shutter speed period. The shutter speed is controlled by the dial switch from “0” to “F.” Video output timing starts right after the internal VD and single shots, FDV is output at the internal VD timing.

FIGURE 15. Timing Chart 1



6.3 ADR (Automatic Dynamic Range) Control

ADR (Automatic Dynamic Range) control is a key algorithm of EN cameras. The ADR algorithm controls the EN camera parameters on a continuous basis to maintain the contrast-to-noise of the license plates on passing vehicles to a suitable level required for automatic license plate reading algorithms. The EN ADR algorithm is unique in that it requires no moving parts and can perform this contrast-maintenance function without having to take multiple images of a vehicle in order to achieve the required plate contrast. The key to this ability is a separate smart light sensor. Each EN camera can communicate with up to two smart light sensors. Using these smart light sensors, the EN cameras automatically optimize Exposure time (or shutter speed), Video Amplifier Gain ("Gain" in short), and A/D converter parameters (Vtop and Vbottom).

Using EN setup software, user can turn on or off ADR control by accessing "Camera ADR Control" config register (Address = 50).

6.3.1 Electronic Shutter

Normally, exposure time is controlled automatically by ADR (Automatic Dynamic Range) control algorithm inside the EN, based on the output from light sensor. However during nighttime installations it is often convenient to manually adjust the shutter time to a larger value so that the focusing targets and vehicle used for setup are easily seen with the available road lighting. Manually adjusting shutter speed can also be useful for certain types of debugging (See Section 7.2, "Problem 2: EN Setup Software Found the Camera, But the Video Image is Too Dark or Just Black," on page 47).

The following exposure times are supported:

TABLE 5. Exposure Times

Shutter Dial	Exposure Time (H)
1	1
2	2
3	3
4	4
5	6
6	8
7	9
8	10
9	11
A	12
B	15
C	31
D	63
E	126
F	262
0	525

When the EN camera is controlled by light sensor, user can monitor the shutter value in ENsetup software by accessing “Camera Shutter” status register (Address = 233). Note that this Shutter value is dial number and not actual exposure time. (left side of the table above).

User needs to set appropriate “ADR Shutter Max” and “ADR Shutter Min” config registers (Address =53 and 58 respectively) to limit exposure time. In daytime, “ADR Shutter Min” limits the shortest exposure time (or faster shutter speed). In night time, “ADR Shutter Max” limits the longest exposure time (or slowest shutter speed). The factory default settings of “ADR Shutter Min” and “ADR Shutter Max” are as follows:

TABLE 6. Factory Default Settings of the ADR Shutter Min. and Max.

Factory Default Settings of ADR Shutter Min. and Max.		
	BW	Color
ADR Shutter Min	Dial=1 (1H)	Dial=3 (3H)
ADR Shutter Max	Dial=6 (8H)	Dial=10 (12H)

6.3.2 Video Amplifier Gain Control

Normally, video amplifier gain is controlled automatically by an ADR (Automatic Dynamic Range) control algorithm inside the EN, based on the output from the light sensor. However, the user can manually change gain value by using the EN setup software (See Section 7.2 on page 47 for more information). Normally, gain would be manually adjusted only when a different gain (and electronic shutter setting) is needed to see the vehicle and focusing targets used for setup in whatever road lighting is available at the installation site.

The following table shows the gain setting vs actual gain (dB):

TABLE 7. Gain Table (BW EN Camera)

Gain Value	dB
0	10
36	12
60	14
83	16
112	18
143	20
176	22
200	24
230	26
255	27.5

Note: Gain Value is Gain entry in camera LUT after calibration.

TABLE 8. Gain Table (Color EN Camera)

Gain Value	dB
0	12
22	14
46	16
74	18
105	20
140	22
165	24
192	26
226	28
250	29.3

Note: Gain Value is Gain entry in camera LUT after calibration.

When the EN camera is controlled by a light sensor, user can monitor the gain value in the EN setup software by accessing "Camera Gain" status register (Address = 232). This Gain value is the Gain Table Entry in LUT after calibration (left side of the table above).

6.3.3 A/D Converter Parameter (Vtop and Vbottom)

Normally, Vtop and Vbottom are controlled automatically by an ADR algorithm inside the EN, based on the output from the light sensor. While manual controls exist for changing Vtop and Vbottom, JAI PULNiX does not recommend that users change the Vtop and Vbottom settings established by the ADR algorithm. A great deal of knowledge is required to set these values correctly, and it is possible to set these parameters so that the A-to-D circuit will not function correctly.

You can manually set Vtop and Vbottom by using the EN setup software (See Section 7.2 on page 47 for more information).

6.4 Flash/Nighttime Light Control

The strobe and continuous nighttime light controls are critical at nighttime. ADR (Automatic Dynamic Range) control inside the EN automatically turns on and off the strobe and night light based on the output from the light sensor. The user can manually turn on and off the strobe and night light if necessary. You need to be able to access the following registers by means of the EN setup software.

Register Address 10: Night Light Control
Register Address 11: Night Light ON threshold and Flash enable.
Register Address 12: Night Light OFF threshold and Flash enable.
Register Address 50: Camera ADR Control

The distance and angle of the strobe unit toward the target is critical and must be optimized. Please refer to the VIS300 Installation Manual for more information.

6.5 External Control

6.5.1 RS-485

The TS-9720EN has the ability to connect multiple cameras on the same RS-485 network. Each camera has an individual ID number selectable via control registers; Camera RS-485 group register (address=107) and Camera RS-485 address registers (address=109). Thus it is possible to send a serial RS-485 trigger to any or all of the cameras. RS-485 communication is accessed via the 26-pin connector on the rear panel of the camera.

RS-485 is typically used by the lane controller to send serial trigger or to send DataID message to validate the HW TTL trigger.

RS-485 is a differential signal communication for longer distance. Since RS-485 is not a common port for PCs, a plug-in 485 board such as ULTRA-485 (Industrial Computer Source, San Diego, CA, 800-523-2320) or compatible is required.

6.5.2 Ethernet

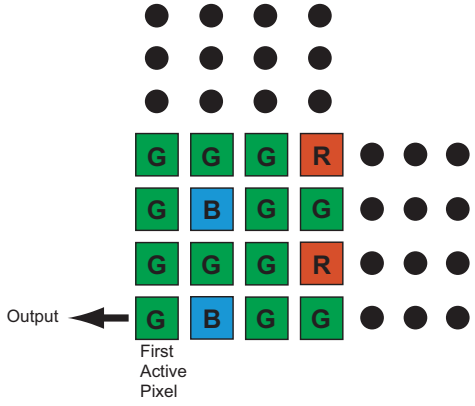
The primary benefit of Ethernet is the scalability of the system; you can add as many EN cameras as you want to the system. For example, you can connect up to 255 Ethernet devices to one class A subnet. Command/Status register access and image transfer are securely done over TCP/IP protocol. In addition to the message-based TCP image transfer, sniffing image on UDP is also supported. Captured images are buffered inside EN camera, and can be automatically transferred to FTP server. Ethernet trigger can be used for applications where time critical response is not required as hardware TTL trigger.

All functions over Ethernet are accessible by EN setup software. Please refer to VIS300 EN Setup User's Guide (Doc Number 4087-72-005).

6.6 Color Filter Array (Color Version)

JAI PULNiX TS-9720EN cameras use the staggered "3G" color mosaic filter pattern (see Figure 16 below). The CFA contains 75% green photo sites and 25% red and blue photo sites.

FIGURE 16. CFA Pattern



Because the color filter array contains only a single R, G or B color in each pixel, the restored image has to fill in colors in the missing pixel locations. The software uses neighboring pixel information to "guess" the missing colors to make smooth, clear images. This is called "color interpolation."

Because the TS-9720EN does not contain internal color-processing circuitry, viewer software must perform color interpolation on host PC side. The EN setup software supports color interpolation.

After color interpolation, white balance must be properly done. Otherwise, gray or white objects cannot be seen as gray or white. Each TS-9720EN camera is calibrated in simulated daytime condition and each image (TIF/JPEG) transferred to host PC contains Rgain and Bgain with regard to Green. By decoding TIF/JPEG header, Viewer software can properly perform white balance. Please refer to "LC To EN Interface Document" (Doc number 69-1198) for more information.

Please note that the factory default setting of the TSC-9720EN turns off Gamma correction, because the non-linearity of the Gamma response curve degrades white balancing. Only linear LUT is used.

Also, it is important to keep in mind that a lossy JPEG encoding will cause color information loss. Viewer software cannot reconstruct the color image properly after it has been encoded to JPEG format. In order to reconstruct the color properly, users must use the raw TIF image format only.

6.7 Image Formats

Two image formats are supported; TIF and JPEG.

The TIF Format image is always ON, and users cannot turn it off. "Image Acquisition 1" and "Image Acquisition 2" config registers (Address = 3 and 9, respectively) control which image format to choose. Multiple image formats, such as both TIF and JPEG, can be selected.

Whether you choose TIF or JPEG format, images sent by the EN cameras contain additional information other than just pixel information. TIF/JPEG header includes ADR information (shutter, gain, Vtop, Vbottom), TimeStamps, Network setting (IP address, MAC address), Error status, and much more. Please refer to the "LC to EN Interface" document for details concerning TIF tagging.

6.7.1 TIF Format

The uncompressed (or raw) TIF format is the best choice to maintain the accuracy of the pixel information for further image analysis and processing.

For the TSC-9720EN (color) model, the user should deal only with the TIF format image, because detailed color pixel information will be lost in the JPEG format image.

Please refer to the "LC to EN Interface" document for the detailed TIF header.

6.7.2 JPEG Format

JPEG is the industry-standard format for lossy image compression. Output file size, quality and speed of the encoding depends on the quality setting. The user can set the proper quality setting by accessing the "JPEG Quality Factor" config register (Address = 46). The factory default is 85.

Access to “Image Acquisition 1” and “Image Acquisition 2” config registers (Address = 3 and 9, respectively) and turn on JPEG format. Factory default setting is TIF format only.

If JPEG quality factor is high (above 85) and image contains complex detail information, the output file size of JPEG encoding becomes larger. JPEG image size must be properly defined in “Storage Setup” of JPEG. If the output file size exceeds the predefined JPEG image size, the result JPEG image will not contain the full resolution of the image. Please refer to Section 6.9, “Image Buffering,” on page 44).

For the TSC-9720EN (color) model, the user should not deal only with the JPEG format image, because this format will not retain detailed color pixel information.

Please refer to the “LC to EN Interface” document for details about the JPEG header.

6.8 Image Transfer

6.8.1 UDP Image Transfer on Setup Channel

The EN camera can send video images over TCP (message-based) on the control channel, or UDP (sniffing mode) on the setup channel, or both. Image transfer over UDP is intended for live video display to focus lens or for sniffing external triggers (HW TTL trigger, Ethernet Trigger, or RS485 Serial Trigger) without disturbing continuous normal operation with Lane Controller. The “Live” or “Snap” buttons on the UDP setup channel do not send images to the FTP server or the lane controller on TCP (message-based) image transfer. Half image and quarter images are supported only on the UDP setup channel. The raw image format is the only one supported by the UDP setup channel; JPEG is not supported.

UDP setup images are easy to enable and disable. The user can access the “EN Setup Trigger Source” register (Address = 111) and “EN Setup Image size” register (Address = 112) to change the trigger source and image size. Live image transfer can be slowed down by setting “EN Setup UDP Inter-Packet Delay” register (Address = 110). It is important to note that when multiple host PCs (clients) connect to the EN camera, only the last client who changes the “EN Setup Trigger Source” register or “EN Setup Image size” register will receive the UDP setup image.

6.8.2 TCP Message-Based Image Transfer on the Control Channel

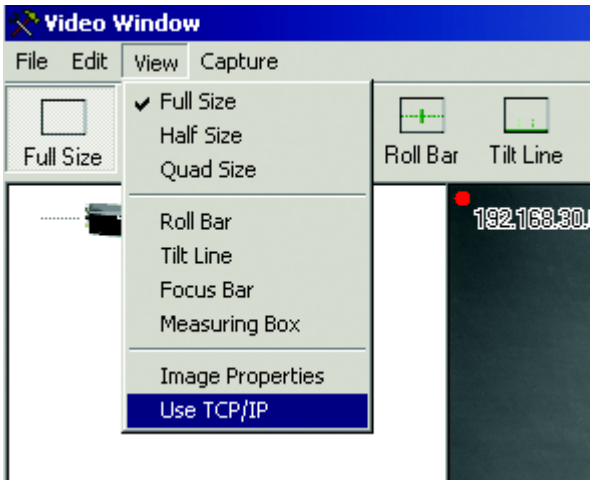
Image transfer over TCP is intended for more secure image transfer. Even if the packet is corrupt, the TCP/IP mechanism automatically resends the missing/corrupt packets. Full size, Odd field, or Even field images are supported and both raw TIF images and compressed JPEG images are supported on TCP control channel.

Unlike the setup channel that can send only one uni-cast UDP image to a single client (host PC), the control channel can send the identical image to multiple host PCs (clients) over TCP. However, the host PC has to respond to “DATA_RDY” message that the EN camera sends when an external trigger is input (HW TTL trigger, Ethernet trigger, or RS-485 trigger). If the host PC sends a “SEND_DATA” message to the EN camera, then the EN camera sends TCP image (TIF, or JPEG, or both) over the Control channel.

For detailed register and interface information, please refer to the “EN to LC Interface” document.

As a default, the EN setup software receives all images over UDP (setup channel). However, if you prefer to switch to TCP images, you can do so by enabling the “Use TCP/IP” option. This is under the “View” menu on the Video Window.

FIGURE 17. Enable TCP Image



An API (application program interface) for Windows is available. Using an API, the time required to develop software for device discovery, command communication, and image transfer can be shortened. Please contact JAI PULNiX for further information.

6.9 Image Buffering

Full size TIF images, JPEG images, and ODD/EVEN field images are independently managed in image buffers. Each buffer is a sequential image queue. When the index reaches the last image, the user can select either to overwrite the oldest image (or the first image), or to stop writing. Also, the user can set the depth of the queue and the size of the JPEG image, while TIF, and ODD/EVEN field image sizes are fixed. These image queue buffer operations are done using EN setup software by accessing the “Storage Setup” command.

As a factory default, the image size and queue depth are defined as the following;

TABLE 9. Factory Default Storage Setup of Image Buffering

	Image Size	Queue Depth
Full Size Image	371K (Fixed)	10 (Changeable)
JPEG Image	100K (Changeable)	20 (Changeable)
ODD/EVEN Field	186K (Fixed)	0 (Changeable)

Please refer to the “EN-to-LC Interface Document” for more information.

6.10 FTP

FTP (File Transfer Protocol) is the industry-standard file transfer protocol. TS-9720EN/TSC-9720EN has an FTP client built-in. TIF image, JPEG image, or both can be transferred to the FTP server automatically.

FTP server's IP address, username, password, and subdirectory name must be properly set by FTP command. Additionally, a 2nd FTP server is supported in case the 1st FTP server is accidentally down. Please refer to the “EN-to-LC Interface” document for the FTP command.

Additionally, the FTP server must be properly set up. Make sure to create a username and password, and to allow read/write/modify access so that the EN camera can write image files in the sub-directory of the FTP server's hard disk. FTP server's hard disk must be regularly cleaned up, otherwise hard disk capacity becomes full and EN camera cannot write image files.

6.11 NTP (Network Time Protocol)

TS-9720EN supports the NTP (Network Time Protocol) client. NTP is the industry-standard time synchronization mechanism over the network. For LAN, the synchronization accuracy within a few milliseconds is achievable. Normally, the EN cameras can maintain the accuracy within 10ms as a worst-case scenario in LAN.

All NTP setup can be done using the EN setup software.

Using the EN setup software, user can access to “NTP client enable” config register (address = 60) to turn ON or OFF the NTP feature. EN camera supports up to 3 NTP servers’ IP addresses (Config register address = 61, 62, and 63).

For the first time when the EN camera is set up for NTP, the EN camera optimizes the drift of the internal clock with regard to the NTP server in your LAN. This takes approximately 1-2 hours to reach within a few millisecond range of the estimated error. This Drift file is saved in non-volatile memory and when power is recycled, the EN camera will read the saved NTP Drift file and the next settlement will not take too long.

If NTP is still not synchronized with the NTP server(s), “NTP status” register (address=239) shows “UNSYNC” status (=0x40). After NTP is finally synchronized with NTP servers(s), “NTP status” register shows “PLL” status (=0x01) and “NTP Estimate Error” status register (address=238) shows the estimated clock drift from the NTP server(s).

If the “NTP Estimate Error” exceeds the values predefined in the “NTP Max Estimate Error” config register (address = 64), then the EN camera sends an error message to the lane controller or any client connecting to EN camera. Please refer to the “LC-to-EN Interface” document for details about this error message.

If you decided to turn OFF the NTP feature, please keep in mind that clock drift is approximately 1.5 second per day. Therefore, you need to send Ethernet command to synchronize the clock from host PC on a regular basis (twice a day, every day, or every few days). Write “Real Time Clock UTC” register

(Address = 102). Please note that the internal millisecond counter is reset to zero when you write a new value to the “Real Time Clock UTC” register.

7 Troubleshooting

7.1 Problem 1: EN Setup Software Does Not Find Any Camera in the Network

1. Make sure that your host PC and EN cameras have the same subnet address, and that their IP addresses are not identical. If the EN camera's IP address is 192.168.30.65, then you should not set the same IP address to the host PC.
2. If you have a firewall set up on your Windows computer, disable it. Also, be sure to enable network data transfer of the EN setup software.
3. If the EN camera's IP address is unknown, use the RS-232 debug cable. For more information, please see Section 2.2.2 (b on page 4.
4. If the EN camera is set to DHCP client mode, then you need DHCP server in your network. Otherwise, a valid IP address is not assigned to the EN camera.

7.2 Problem 2: EN Setup Software Found the Camera, But the Video Image is Too Dark or Just Black

1. Make sure that the iris of the lens is open. If the light sensor is connected, then it is controlling the camera parameters such as shutter, gain, white level (vtop) and black level (vbot). If the light sensor is set up outdoors and the EN camera is set up indoors in the daytime, then the image will look very dark, because the camera parameter is probably set to the highest shutter (1H exposure time), and lowest gain (Gain=min, Vtop=max, Vbot=min).
2. If you want to manually set camera parameters instead of light sensor control, you can do so by using EN setup software. In Video control window, right-click on the camera icon. Select "Manual Video Adjust." Set appropriate camera parameters manually. See Figure 6.2, "Asynchronous Reset," on page 36 for details about the camera parameters.

7.3 Problem 3: TTL Trigger/Ethernet Trigger/Serial RS-485 Trigger Does not Generate Trigger

1. Make sure that the "Trigger" register is set properly to enable TTL Trigger/Ethernet Trigger/Serial RS-485 trigger. In the "Properties" window of the EN setup software, you can read/write "Trigger" register.
2. If you choose dataID source to be RS-485 or Ethernet, make sure to send dataID within the pre/post message time window defined in those registers. If there is no dataID or the dataID is sent after or before the predefined window, then the trigger will be rejected as an invalid trigger. Make sure that you set the appropriate time pre/post message time window. The factory default setting of dataID source is self-generate mode.
3. If the TTL trigger is noisy, then pre/post trigger condition filter may reject the trigger input to the camera. TTL trigger must stay stable for a certain predefine pre-time before the trigger edge and post-time after the trigger edge. If not, then the trigger will not be generated. The factory default of pre- and post-time trigger is 1ms.
4. If TTL trigger pulse is noisy, then the trigger noise filter may reject the trigger input. TTL trigger pulse width smaller than pre-defined trigger filter time is ignored automatically by the FPGA as noise. The trigger noise filter factory default setting is 100us.

7.4 Problem 4: JPEG Image is Either Corrupt or Not a Full-Size Image

If the JPEG image size is set to be too small but the JPEG quality setting is too high, then the EN will fail to save entire resolutions of JPEG. The user can either increase the size of JPEG image size (See the Allocate Image Size section), or decrease JPEG Quality Setting. The factory default JPEG image size is 100Kbyte, and quality setting is 85.

7.5 Problem 5: EN Camera Does Not Send any FTP Image to the FTP Server

1. Make sure that the FTP server allows anonymous user for full-access operation (write/read/modify/create directories).
2. If anonymous user is not used, make sure that the User Name, and Password on the FTP-client register settings on the EN side match those of the FTP-server setting on the host side.
3. Make sure that the FTP-server has enough hard disk space to store TIF/JPEG images.

7.6 Problem 6: EN Camera Does Not Connect to Light Sensor or the Connection is Not Reliable

1. Make sure that you set the proper IP address and port number of the light sensor into the EN registers.
2. Verify that the ADR register is be set to “Auto” in order to connect to the light sensor.
3. Verify that the Moxa (RS-485 to Ethernet converter) is set properly with the latest firmware. See document (“VIS300 Installation Manual,” Appendix B, doc. number 4087.72.004). Make sure to set the local TCP port and command port properly.
4. Connect via Telnet to the Moxa converter. If the IP address of your Moxa is 10.0.0.50, then type the following from Command Prompt.

   telnet 10.0.0.50

```
------------------------------------------------------------
Model name       : NPort 5232
MAC address      : 00:90:E8:09:BE:EC
Serial No        : 17
Firmware version : 2.0
------------------------------------------------------------
<< Main Menu >>
(1) Basic settings
(2) Network settings
(3) Serial settings
(4) Operating settings
(5) Accessible IP settings
(6) Auto warning settings
(7) Monitor
(8) Ping
(9) Change password
(a) Load factory default
(v) View settings
(s) Save/Restart
```

(q) Quit

Key in your selection:

Here you should select 7 (Monitor)

Key in your selection: 7

<< Main Menu->Monitor >>
(1) Line
(2) Async
(3) Async-setting
(m) Back to main menu
(q) Quit

Key in your selection:

Here you should select 1 (Line)

Then you will get a display like this:

Port	Type	IP1	IP2	IP3	IP4
01	TCP Server	10.0.0.101	10.0.0.102	Listen	Listen
02	TCP Server	Listen			

5. Press “q” to cancel. This will bring up a screen displaying who is connected to the Moxa NPort device. If you have reached the limit of numbers of simultaneous connections, this information will explain why additional users cannot connect to the Moxa device.

7.7 Problem 7: IO Board Communication Error

The IO board has a temperature sensor, a housing-open sensor, and other event sensors. When these events occur, the IO board sends a warning to the EN camera through the 9600 bps UART. If you are not using an IO board and a 26-pin HD-Sub cable, then you will have an IO board communication error message. In this situation, you can simply ignore this message.

If you are using an IO board and a 26-pin HD-Sub cable and still see an IO board communication error, then the baud rate of the EN camera may not match that of the IO board communication UART. In this situation, you need to set the EN IO board rate register to 9600 bps, so that it matches the IO board UART factory default (9600bps).

7.8 Problem 8: Night Time Image is Too Bright and License Plate is Whited Out or Saturated

1. Make sure that the light sensor is connected to the EN camera (Set ADR register to Auto).
2. Add ADR A offset to reduce the gain at night time. ADR offset is used only when the night light is turned on. When ADR A offset is high, the EN camera reduces the system gain and the brightness of the license plate is reduced. Add only to ADR A offset.

7.9 Problem 9: Timestamp is Not Set to Current Local Time

1. Use the EN setup software to set local time. In the “Property” window, find the “Real Time Clock” register. If NTP is OFF, then the displayed time is estimated to drift about 1.5 second per day.
2. If NTP is ON, then the time is automatically synchronized with the NTP server. However, the timestamp inside the TIF/JPEG header is UTC in GMT time zone. The viewer’s software will need to decode the UTC (GMT time zone) to sync appropriately with local time.

7.10 Information and Support Resources

For further information and support:

Phone:	(408) 383-0300
	(800) 445-5444
Fax:	(408) 383-0301
E-mail:	imaging@jaipulnix.com
Mail:	JAI PULNiX, Inc.
	Sales Department
	625 River Oaks Parkway
	San Jose, CA 95134
	ATTN: Video Applications
Web Site:	www.jaipulnix.com

8 Appendix

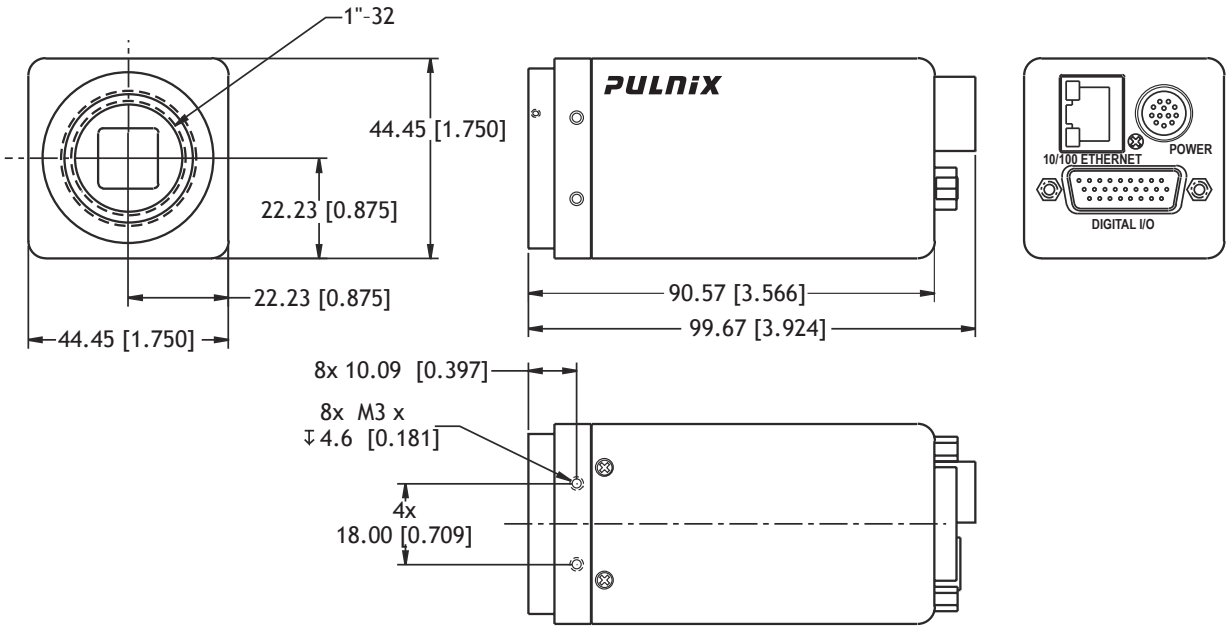
8.1 Specifications

TABLE 10. TS-9720EN Series Product Specifications Table

Model	**TS-9720EN Series**
Imager	2/3" progressive scan interline transfer CCD
Active Area	9.9mm (H) x 7.7mm (V)
Active Pixels	768 (H) x 484 (V)
Cell size	11.6µm x 13.6µm
Data Clock Output	14.318 MHz
Resolution	Digital: 768 (H) x 484 (V)
S/N Ratio	50dB min. (AGC off)
Color Mixture	0.5% max (color model only)
Min. Illumination	1.0 lux, f=1.4 (no shutter) @ 30fps
Video Output	Digital output: JAI PULNiX proprietary protocol over TCP/IP
Gamma	Gamma 0.55 for BW Linear for Color
Lens Mount	C-mount
Power Req.	12V DC±10%, 450 mA (typical at 25° C) (1.2A required at power-up)
Operating Temp.	-10° C to 55° C
Random Vibration	$7G_{rms}$ (10Hz to 2000Hz)
Shock	70G
Size (W x H x L)	44mm x 44mm x 64mm (1.73" x 1.73" x 2.51")
Weight	213 grams, 7.5 oz.
TS-9720EN Processor Module	
CPU	Power PC
SDRAM	64 MB
O/S	Real-time Linux
External I/O Interfaces	
Trigger Interface	TTL, serial, or Ethernet input. Minimum time between successive triggers: ~33ms
Ethernet Interface	10/100 BaseT Ethernet, TCP/IP, UDP, and FTP
Serial Interfaces	2 UARTs and one RS-232 debug port

8.2 Physical Dimensions

FIGURE 18. Physical Dimensions



8.3 Spectral Response

FIGURE 19. Spectral Response (B/W CCD for TS-9720EN)

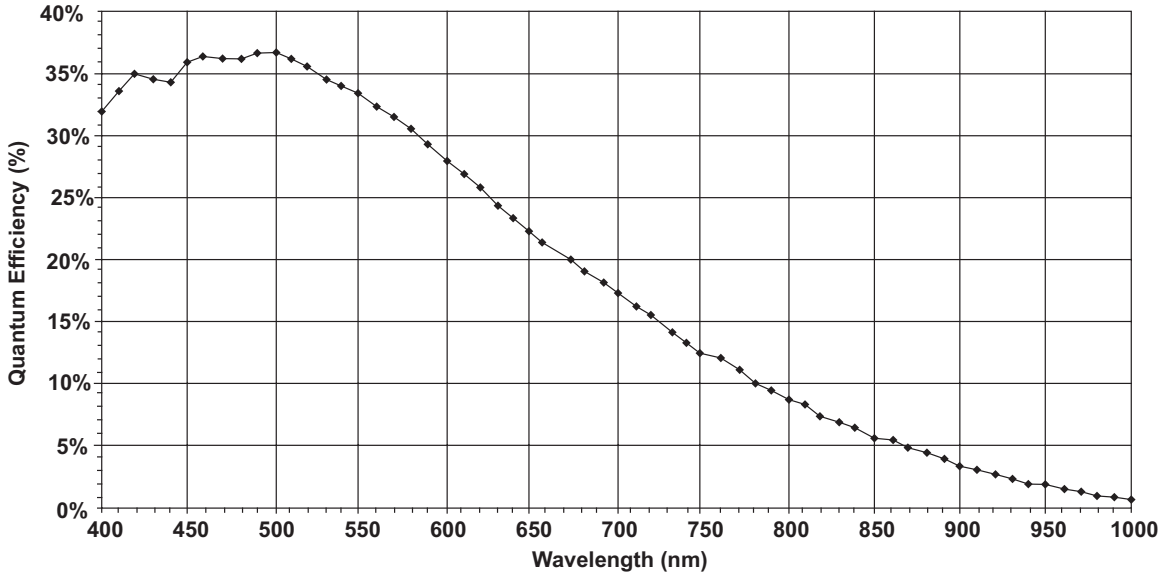


FIGURE 20. **Spectral Response (Color CCD for TSC-9720EN Only)**

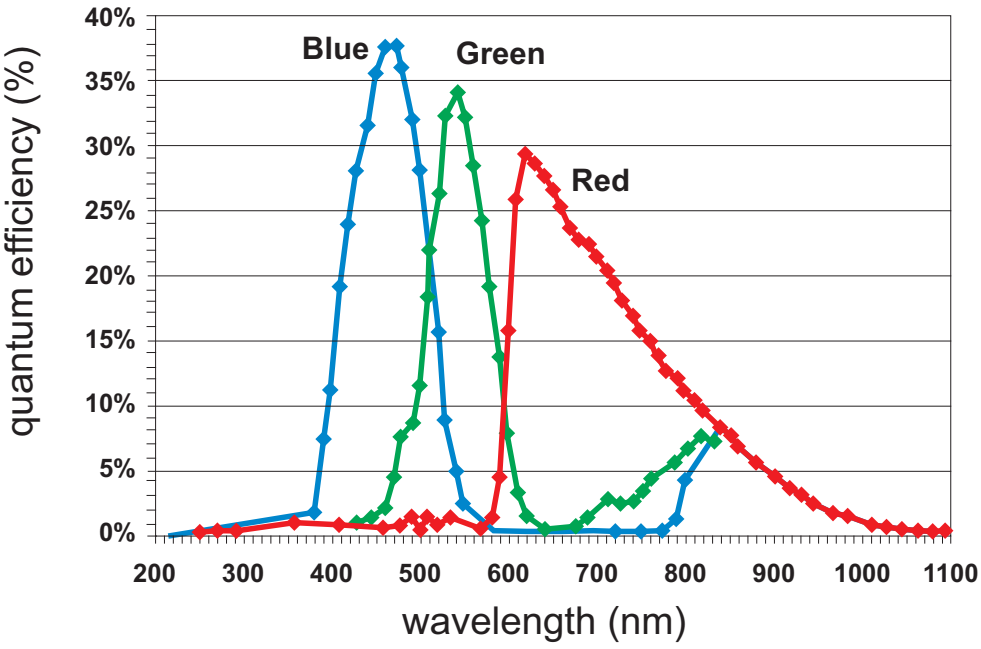
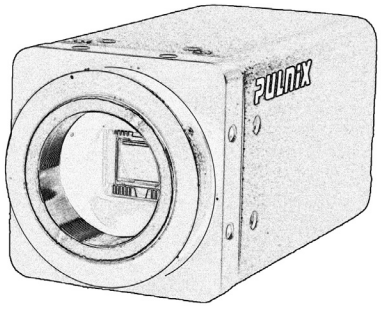


TABLE 11. **IR Cut Filter Optical Characteristics**

Wavelength	Transmission
from 450 to 650 nm	Average 80% above
730 ± 20 nm	Average 50%
from 800 to 1,150 nm	Average 10% below



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